THE

ELECTRICAL REVIEW.

VOL. XLIV. MAY 26, 1899. No. 1,122.

CONTENTS:

	PAGE
The Legal Relationship of Joint Patentees	841
Indispensable Accessories of Electric Traction (*illus.*) (*continued*)	843
Methods for Detecting the Arrivals of Small Faults on Board while a Ship is Picking up Cable (*illustrated*)	846
Note on the Heating of Commutators (*illustrated*)	848
Capacity Measurement of Submarine Cables in connection with the K R Law for Speed of Signalling	848
Leeds City Tramways	850
Legal	851
Correspondence:—Electric Piping...	852
The Victoria Accumulator	853
Electrical Energy produced directly from Carbon	853
Re Nernst's Lecture	853
Re Telephone Cables	854
Business Notices, &c.	854
The Potteries Electric Tramways (*illustrated*) (*concluded*) ...	859
The Lighting of a Cycle Track (*illustrated*)	861
Oceanic Research and the Submarine Telegraph (*concluded*) ...	861
Notes	865
City Notes	869
Traffic Receipts	870
Share List of Electrical Companies	871
Market Quotations	872
Single Line Block Signalling (*illustrated*)	873
The Telephone Service	873
Some Experiments with the Caldwell Interrupters (*illustrated*)	874
Magnetism (*illustrated*) (*continued*)...	875
Machine Shop Management in Europe and America	876
The Northern Society of Electrical Engineers:— Miscellaneous Notes on the Cheltenham Mains (*illustrated*) (*concluded*)	876
Electric Lighting Progress in St. Pancras	878
Aluminium for Switch Work, Bus Bars, &c.	878
New Patents	879
Abstracts of Published Specifications	880

THE

UNIVERSAL ELECTRICAL DIRECTORY

1899

Edition

Price 6s.

NOW READY.

H. ALABASTER, GATEHOUSE & CO.,

4, LUDGATE HILL, LONDON E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

CAN BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON.

Telegraphic Address: "AGENRAY, LONDON." Code A B C.

Telephone No. 988 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To *all other countries*, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s. or Free by Post (in Great Britain), 6s. 6d

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 29, Rue de la Banque. *Berlin:* ASHER & Co., 13, Unter den Linden.

Cheques and Postal Orders (on Chief Office London, to be made payable to Mr H. ALABASTER, 4, Ludgate Hill, E.C.

THE LEGAL RELATIONSHIP OF JOINT PATENTEES.

IN the case of the National Society for the Distribution of Electricity by Secondary Generators, Limited, *v.* Gibbs, which came before Mr. Justice Cozens-Hardy in the Chancery Division a short time ago, some important questions as to the legal rights of patentees, "their executors, administrators and assigns," were discussed. The facts of the case, as reported in our issue of May 5th, were shortly as follows:—In 1882 a grant was made unto Lucien Gaulard and John Dixon Gibbs of letters patent for an invention for a new system of electricity for the production of light and power.

The grant was in the following form:—"Unto the said Lucien Gaulard and John Dixon Gibbs, their executors, administrators and assigns, and every of them by themselves or by their deputy or deputies, servants or agents, or such others as they the said Gaulard and Gibbs, &c., shall at any time agree with and no others and from time to time and at all times hereafter during the term of years expressed shall and lawfully may make use, exercise, and vend their said invention within the United Kingdom in such manner as to them the said Gaulard and Gibbs, their executors, administrators and assigns or any of them shall in their discretion seem meet, and that the said Gaulard and Gibbs, their executors, administrators and assigns shall and lawfully may have and enjoy the whole profit, and benefit, coming by reason of the invention."

By an agreement under seal dated May 25th, 1883, Gaulard and Gibbs agreed to sell to the plaintiff company the exclusive privilege of using, exercising and vending all the inventions within the United Kingdom and other countries named with the full benefit of all extensions, &c. Gaulard and Gibbs agreed (1) to procure confirmation of the patents if and when necessary; (2) to allow the plaintiff company to bring and prosecute actions for infringement in their names; (3) to establish a title to the patents at the expense of the plaintiff company; (4) to accept the sum of £220,000 payable as in the agreement mentioned in respect of the said assignment. It was also agreed that the assignment should contain a covenant by the vendors "that all the letters patent thereby assigned, or any letters patent which might have been obtained in substitution for the same, or in respect of such invention as is protected thereby, were valid, and in nowise void or voidable." Gaulard died in 1888, and Mme. Ruelle, one of the defendants, was his administratrix.

The action was brought in respect of a breach of the last mentioned covenant, it being alleged that the patents were entirely, or in part, void or voidable, and that they had actually been declared void or voidable. The plaintiff company therefore claimed damages. A compromise was effected with the defendant Gibbs, but the sole question in the

present action was proceeded with in order to determine the liability of Gaulard's representatives.

In the course of his judgment, Mr. Justice Cozens-Hardy said:—"I think the two patentees took a joint interest which passed by survivorship to Gibbs on the death of Gaulard. . . . . In my opinion, Gaulard's representative is not a proper party to the action, in so far as it seeks an order for the assignment of the patents, inasmuch as the whole interest in the patents is vested in Gibbs, as the survivor of the two joint patentees."

The above case can hardly be understood without a short explanation of the distinction between joint tenancy and tenancy in common. To the non-legal mind the difference is not apparent, but it is nevertheless real. In the case of joint tenancy the interest of the parties commences at the same time. They are each in possession, and they have an equally good title. Tenants in common, on the other hand, have only one mutual interest, and that is, possession of the property in question. Their respective titles may have been derived from different sources, and may have commenced or may be about to cease at different times. The real and important distinction, however, does not become apparent until we have considered the question of devolution on the death (*a*) of a joint tenant, (*b*) of a tenant in common. In the case of a joint tenant his interest passes to the other tenant and not to his executors, while the rights and liabilities of a tenant in common do become vested in his representatives. The importance of this distinction requires but little elaboration. Suppose a patentee to whom letters patent have been granted in conjunction with someone else, is anxious that his share of the future profits shall enure for the benefit of those who come after him.

If his collaborator to whom the original patents were granted in conjunction with himself is his joint tenant, the profits arising out of the patent become absolutely vested in the survivor upon the decease of his partner, to the entire exclusion of those whom it was desired to benefit. If, on the other hand, they are co-partners, tenants in common, the share of the deceased in the subject matter of letters patent becomes vested in his executors to be ultimately applied according to the terms of the will was desired to benefit.

The first question which arose in the case before was whether to use a legal phrase Gaulard and Gibbs took as joint tenants or tenants in common. If in the case of ordinary property the ownership is vested in two persons as joint tenants, we have seen that upon the death of either one the entire property is transferred to the other. Where they take as tenants in common upon the decease of one his share goes to his executors. If the same rule applies to patents and the property therein, it would seem that Mme. Ruelle, if her husband was a tenant in common, must have been held liable under the covenants in the agreement with the plaintiff company.

Assuming that Gibbs and Gaulard were jointly interested in the patents, a second question then arose as to whether the covenant by which the validity of the patents was guaranteed was joint or several. It will be easily seen how important this question might become to the purchasers if the more substantial of the two vendors of a patented article were to die. Redress for breach of covenant might then be sought in vain.

As Mr. Justice Cozens-Hardy pointed out, the covenant was a peculiar and special stipulation for which the plaintiff had bargained, and having regard to its exact wording, he saw no reason why, in the events which had happened, the performance of the covenant should not rest entirely with the survivor. In support of this he cited the case of White *v.* Tyndall and Others (H. L., 13, Ap. Cas. 263), which affords a very striking instance of the way in which the Court is inclined to put a strict interpretation on covenants of this kind. Premises were demised to two persons, their executors, administrators and assigns, as tenants in common, and not as joint tenants at a yearly rent. They covenanted "for themselves, their executors, administrators and assigns, that they, the said G. and A., or some or one of them their executors, administrators or assigns," would pay the said yearly rent and keep the premises in repair. G. having died, the lessor sued A. and G.'s executors for breaches of covenant which occurred after G.'s death. It was decided that the covenant, which is similar in form to that used in the present case, was *joint*, and not several, and that the executors were not liable. Lord Halsbury, in the course of his judgment, pointed out that although the parties had covenanted to hold the premises "as tenants in common," the liability in respect of rent was clearly joint.

From this case it would seem that even the express use of the word "joint" is not of itself sufficient to invest the transaction with the characteristics which are usually associated with joint liability. Of course it may be said that the matter cuts both ways. The discharge of onerous covenants (as in the present case) may fall upon the surviving patentees, who cannot obtain contribution from the executors of a deceased "joint tenant," which he might be able to demand at the hands of the representatives of a deceased "tenant in common." And if it is important to examine the terms of the grant of letters patent, it is doubly necessary to scrutinise the terms of an assignment which contains covenants as to the validity of patents.

Electricity in Turkey.—Till recently the employment of electricity in any shape or form in Constantinople was strictly forbidden. For an unfortunate official to mention the word "electricity" in the hearing of the Sultan was as much as his place, if not his head, was worth. Incredible as it may appear, his Serene Highness naively imagined that a dynamo must have something to do with the manufacture of dynamite. So much is there in a name. The final triumph over the prejudices of the Sultan is said to have been due to a Spaniard and the kinematograph. This Spaniard, Don Ramirez by name, started a circus in Constantinople, and in order to be up to date, imported a kinematograph. But the city authorities would not allow him to set his new instrument in operation, because it had to be driven by the condemned electricity. In his difficulty he applied to his ambassador, who promised to do his best for him. During the next audience which he had with the Sultan, the wily diplomatist took occasion to enlarge on the wonders of the kinematograph, and interested the Sultan so much, that Don Ramirez was ordered to bring his instrument to the Palace. Moving scenes from the leading capitals of Europe were thrown on the screen for the delectation of the Sultan, who no doubt enjoyed them all the more, since he is not, like his friend the German Kaiser, a great traveller. Among the indirect results of this exhibition was that the Sultan became convinced that electricity, though produced by a dynamo or a battery, had no connection with dangerous explosives; the lucky Don got kudos and wealth, and permission was granted to him to instal in his circus the first electric lighting plant in Constantinople.

INDISPENSABLE ACCESSORIES OF ELECTRIC TRACTION.

By HENRY E. P. COTTRELL, A.M.I.C.E.

(*Continued from page* 758.)

Brakes.

Since the introduction of electric traction on tramways and light railways, the question of brakes has become year by year of greater importance. Inventors have been at least as prolific in designing devices connected with these indispensable accessories as they have been throughout the vast field opened to their ingenuity by the requirements of electric traction generally. The number of inefficient and faulty devices, of expensive and complicated details, proposed and experimented upon, has been practically endless, and in general it may be confidently stated that none of the mechanical devices have been any great improvement over the old wheel and ratchet in point of speed of application, although several have introduced a valuable additional leverage in aid of the hand power applied by the brakesman, which has enabled the brakes to be applied with increased power in the same interval of time. In the ordinary form of brake gear (fig. 31) the brake beams are hung from links attached to the side framing of the truck, and the brake blocks are applied to the wheels by the moving of these beams towards the wheels by suitable leverage applied through the brake framing. The blocks are disengaged by springs acting against the brake beams, which are compressed in putting on the brakes. The chief drawbacks incident on link hung brakes is the kicking and rattling which invariably attends their application and release; this is due partly to the method of suspension and partly to the unequal action of the springs, and testifies to the fact of the brake blocks being uncertainly and unequally applied, and therefore being unreliable in their operation. The simplest and most efficient device overcoming these defects is the "Gravity" brake. In this form of brake the brake beams are carried in gravity slides, as shown in the accompanying figure (32). Here the release springs are done away with altogether, the brake blocks being disengaged automatically on releasing of the brake gearing by the weight of the brake beams and heads, causing the former to slide down the inclined framing. A considerable saving of power in applying the brakes is thus effected, as there are no springs to compress, and the action of gravity being far more certain than that of even the best of springs, the brake blocks are released from the wheels quicker and more certainly than with springs. This form of brake rigging is extensively used with the Peckham single trucks, both in America and the United Kingdom, with the best results.

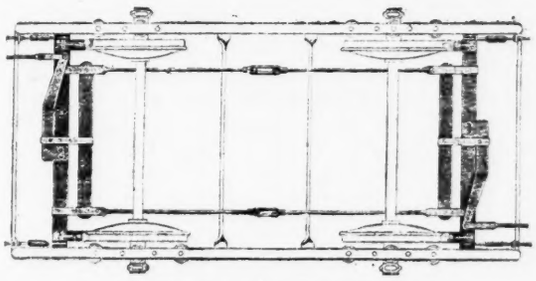


Fig. 31.—Peckham's Lever Brake.

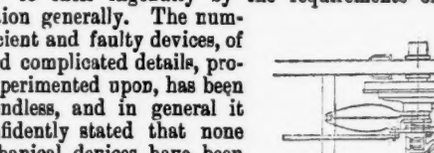


Fig. 32.—Metropolitan Gravity Brake.

The simplest and most efficient mechanical device for supplementing the hand power exerted by the brakesman without generating additional power, is that known under the name of "Price's" friction power brake. In this the accumulated momentum of the car is utilised in stopping the same by applying it at the extremity of suitable leverage. Figs. 33 and 34 show the application of this form of brake to a single truck, and to a double truck car. Ordinary brake rigging is used, but the chain, instead of being brought to the brake staff, is attached to a drum sleeve on the axle. This drum sleeve or disc is loose when the brake is not in use. When the brake is applied, however, this disc is pressed by a system of levers against a corresponding disc attached to the inside of the wheel, there being a leather washer between the two discs to prevent the surfaces from being ground down. The friction caused by pressing the two discs against each other, causes the loose or idler sleeve to revolve, winding up the chain and setting on the brakes. The sleeves are automatically lubricated so as to ensure their running perfectly freely on the axles when the brakes are not in use, but the leather washer between the discs is carefully protected from contact with lubricant.

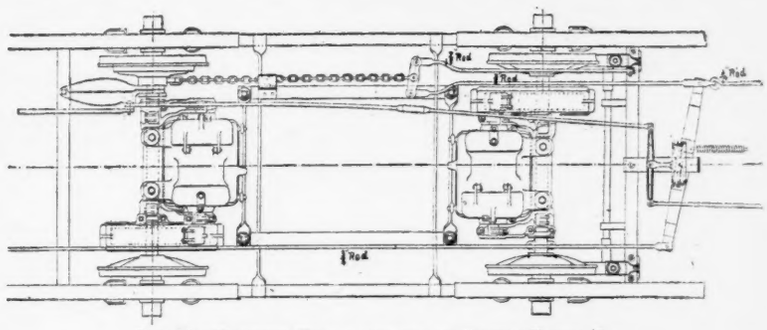


Fig. 33.—Friction Brake applied to Single Truck Car.

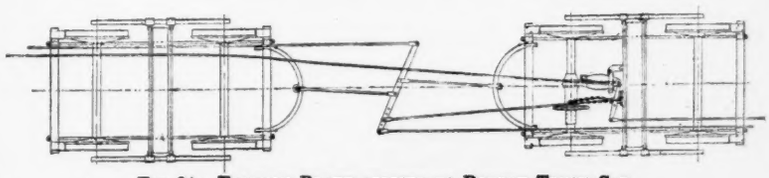


Fig. 34.—Friction Brake applied to Double Truck Car.

A special advantage offered by this form of momentum brake is the way in which the pressure between the idler sleeve and the sleeve fixed to the back of the wheel is self-graduated to a considerable extent by the leather disc or washer between their surfaces; this being compressible, compensates to a large extent for any excess of pressure due to heating of the wheels and blocks, or swinging of the truck in passing round a curve, a quality in which these mechanical devices are generally deficient. The increased leverage afforded by the winding of the brake chain on the idler sleeve by the application of the momentum of the car through the wheels can be increased to any desired extent, and the hand power exerted by the brakesman multiplied in the same proportion. Thus the element of uncertainty and insufficiency attendant on the majority of mechanical brakes can be largely done away with by the adoption of the combined devices above described which are inexpensive, simple, and effective.

D

In an ordinary lever or gravitation brake and also in a brake utilising the momentum of the car for its application, the ratchet handle with which it is applied by the motor man is an accessory of considerable importance. The ordinary form by which the ratchet is held with a pawl, generally disengagable by hand, is the most familiar and had its origin in the appurtenances of the parent horse car. Its chief defect lies in the rattle it makes when applied, and in the liability of the pawl to wear out rapidly with the teeth of the ratchet, so that in a comparatively short time the ratchet handle becomes unreliable. An adaptation of the device patented many years ago by Brégnet, the well-known French instrument maker, in connection with watches as a first step to the keyless watch, has been applied to handles for brakes, and is known as the Kelsey noiseless ratchet brake. Besides being an ingenious application of a very interesting device, it overcomes completely the defects pointed out above. Fig. 35 (A, B, C) explains the construction of this brake

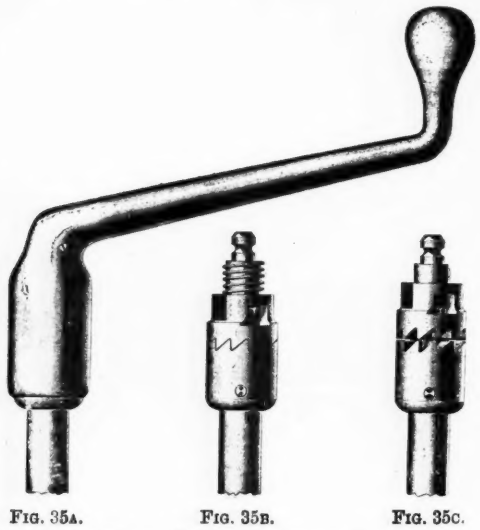


Fig. 35A. Fig. 35B. Fig. 35C.

The Kelsey Noiseless Ratchet Brake.

handle, by which it will be seen that when it is moved in the direction in which the brake is applied, the spiral spring forces the top row of teeth into the lower sockets, from which they cannot disengage except when the handle is turned in the opposite direction, then they at once work up the inclined planes at the back of the teeth and the spring remains compressed till the motion is again reversed. The strength of this type of clutch is too well known to require mentioning; it is practically noiseless in operation and the wear on the teeth is insignificant.

The speed at which electric roads are worked being steadily on the increase, makes it more than doubtful whether hand power alone, however much multiplied by mechanical devices, could ever prove permanently sufficient to cope with the exigencies of brake application under these more trying conditions. The speed of electric tramways in the older and more crowded cities, which also generally possess the narrower and more tortuous thoroughfares, is, of course, not likely to alter to any great extent even were horse traction to entirely disappear, and here the improved mechanical brake will always find a legitimate field. But in the newer centres which possess broader and straighter thoroughfares, electric tramways can be worked under conditions of speed approximating to suburban and interurban railways, and here brakes of the character of the vacuum and plenum brakes, which have long supplemented or replaced mechanical brakes on railways, are even more essentially necessary, because emergency stops are both more frequent and more urgent on a tramway than on a railway. On an electric road no steam being available, the power for brakes of the class in question has to be compressed air; this has either to be compressed at the generating station or by the momentum of the cars, or by special motors, and the compressed air stored on each car for use. In other words, power brakes must be air brakes with the air compression produced by special plant at a generating station or off the axles or off supplementary motors carried for the purpose, additional to the driving motors on the cars. The use of compressed air as the medium for working the brakes presents special advantages in that it possesses the essential property of elastic cushion to a practically unlimited extent.

It was pointed out in describing Price's momentum brake that the leather washer, being compressible, afforded a certain though limited amount of elastic cushion to this brake, and that for this reason it was a great improvement on the

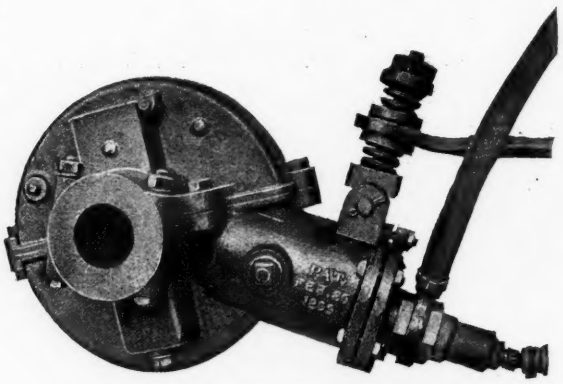


Fig. 36A.—Axle Compressor and Governor.
Suitable where wide space is available on axle.

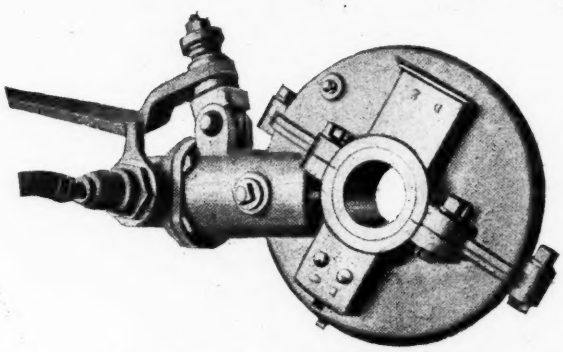


Fig. 36B.—Axle Compressor and Governor
Suitable where narrow space only is available on axle.

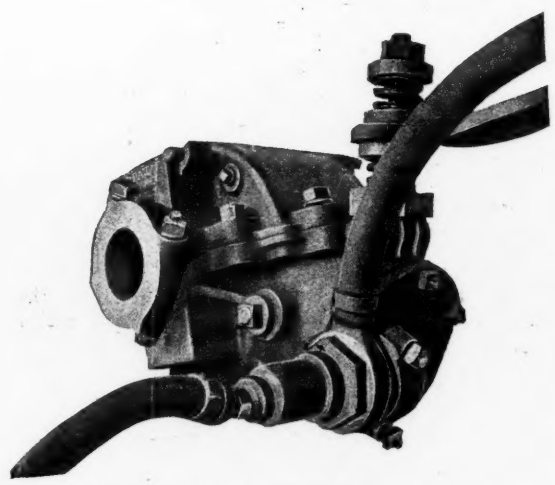


Fig. 36C.—Axle Compressor and Governor.
Suitable for Pony Axle.

ordinary rigidly applied mechanical brake, it relieved to a certain extent the excessive and undue pressure caused by the expansion of wheels and brake blocks through heat generated by the sudden application of the latter or the swinging of the truck passing round a sharp curve, and avoided the undesirable skidding of the wheels and the consequent flattening of the wheel treads and possible

derailment of the car. A properly constructed and applied brake should never act as a skid, but the number of revolutions of the wheels to which a brake is applied should be diminished thereby to any required extent without being reduced to zero. In other words, the friction between the wheel treads and the rails should always be a rolling friction and not friction between two fixed metal surfaces, otherwise the wear and tear of both is vastly and unnecessarily increased to the especial detriment of the wheels.

With a brake the medium for applying which is compressed air, if an unintended pressure is brought from any cause on to the brake blocks, the air in the brake cylinder, which is always in a compressible condition, takes up this excess of pressure in the same way as a coiled spring or rubber cushion, and prevents it from being exerted against the wheels so as to skid them, the excess if continued being dissipated by the automatic arrangement regulating the limits of pressure in the cylinder itself. This invaluable feature of cushioned action is inherent to this form of power brake, and makes it particularly suitable for electric traction. The chief desiderata in a power brake are the following :—

1. Time required for applying the brake blocks to wheels to be reduced to a minimum.

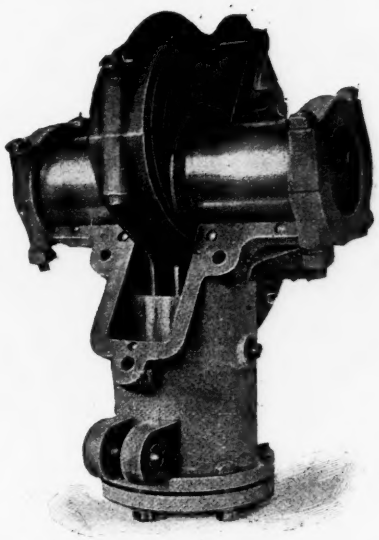


Fig. 37A.—Axle Compressor (with top half of casing removed).

2. Pressure between blocks and wheels to be constant and never to exceed a designed maximum.

3. The release of the blocks to be complete and practically instantaneous when pressure is taken off.

4. The friction between the surfaces of wheels and blocks, and wheels and rails, to be always rolling and not fixed.

These desiderata are all satisfactorily met both by the Westinghouse and Christensen air brakes, which are more and more extensively used to the exclusion of other types for heavy loads and high speeds on electric railways in the States, in Great Britain, and in Europe.

The Westinghouse brake is too well known to require description here, suffice it to say that this brake as fitted to the motor cars and trailers is identical in all respects with the type in use on all railways for engines and carriages. The only difference being that the steel air reservoirs $\frac{3}{16}$-inch in thickness are generally of smaller proportions than those in use for steam on railways (ranging on tramways from 4 inches to 10 inches in diameter). It is usual on Westinghouse installations to provide a charging equipment at the power stations for the supply of compressed air (pressure being from 80 to 120 lbs. per square inch). This system of providing compressed air has been followed on the City and South London and the Liverpool Overhead Railway, and on many other lines in America and Europe, but on the former, is now being tentatively replaced by motor compressors fitted on the trains themselves. The air is delivered on the brake cylinders through reducing valves at 50 lbs. pressure, and the minimum limit is fixed at 40 lbs. The Westinghouse brakes are also worked by air stored in the reservoirs carried either on the motor car or the trailer and compressed by special compressors worked off the axles in a way similar to that described lower down. The comparison as to cost of a single charging station and motor compressors on each unit is distinctly in favour of the former, although the independent system is coming more and more into favour with engineers. This is probably due to the unavoidable delays involved in bringing the cars up to the charging station when the reservoirs are exhausted. These are usually proportioned so as to supply sufficient air for 80 stops. On a small system, where the number of units running is limited to 8, the relative cost of charging station equipment to motor compressor equipment per unit is as $79\frac{1}{3}$ to $115\frac{1}{3}$. With a greater number of running units the cost of the charging station is not proportionately increased, and the cost of maintenance is also largely in favour of the charging station.

Both the Westinghouse and Christensen brakes are plenum brakes, the vacuum brakes being unsuitable to electric traction owing to the greater necessity for economising space and weight on electric tramways than on steam railways, and also the greater liability of the brake blocks working away from the position which ensures the correct leverage, and the consequent increased necessity for adjustment. The necessity for making certain of a quick stop on a tramway is generally far more important than on a railway, and it is, therefore, imperative that the brakes should be in condition to exert their maximum pressure at any moment without fail, and this no amount of practical over-

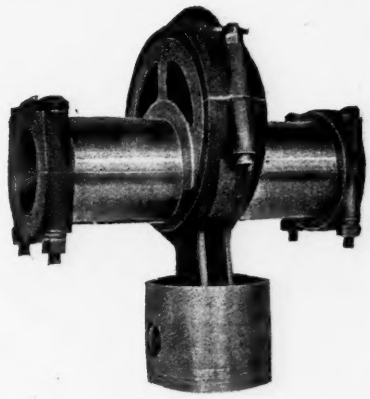


Fig. 37B.—Eccentric (Eccentric Stays and Piston assembled.)

hauling could possibly ensure with brakes worked on the vacuum principle in an electric tramway. There are two forms of Christensen brake, the one obtaining its power from the axles of the vehicles to which the brakes are applied, the other from special motors. In the first form an eccentric (fig. 36) is dowel-pinned on to the axle, and enclosed is a dust-proof casing, partially filled with oil. This eccentric works the compressor piston by a strap to which a double plunger is attached (see fig. 37). The compressor is slung from the car framing with a hinged joint, and a double-spring inelastic suspension, so that no jars can damage the compressor. This method of suspension enables compressor to follow all the motions of the axle in the journal bearings, and of the springs in the truck framing, and thus ensures the centre line of the cylinder being constantly at right angles to the centre line of the axle and the exactitude of the movement of the piston in the compressor body, minimising wear and tear and chance of crippling. The reservoir is either one large seamless cold-drawn steel shell, tested to 600 lbs., or where space does not permit, two small ones, of the capacity of 10,000 cubic inches. The air pressure in these cylinders is regulated by a governor of the simplest construction which is readily removable, consisting of a spring-loaded plunger moving in a valve body connecting with the suction and discharge hoses through valves. This plunger is so adjusted that when the maximum pressure in the compressor is attained, the suction valve port is closed and the discharge opened, and the air freely passes backwards and forwards through the suction hose without compression till the

pressure is reduced to a certain minimum, when the plunger reverses its motion and the compression is resumed. The limit between the pressures does not exceed 12 lbs. The regulation of the pressure applied to the brake blocks is effected by the adjustment of the leverage connecting their frames with the brake cylinder pistons in proportion to the maximum working pressure of the compressors, which is varied to suit the maximum weights and speeds of the service. The brake cylinders are so constructed as not to interfere with the brakes being worked by hand power, if that is retained for ordinary use.

(To be continued.)

ERRATUM.—With reference to Table VI. on page 713 of the ELECTRICAL REVIEW for May 5th, the author finds that an inadvertent error was made in stating that the information from which the table was prepared was derived from the books of the New York Car Wheel Works, it should have been from the books of the Consolidated Traction Company, to whom the former company supply wheels.

METHODS FOR DETECTING THE ARRIVALS OF SMALL FAULTS ON BOARD WHILE A SHIP IS PICKING UP CABLE.

Two methods having the above object and presenting very similar characteristics have been published by Mr. W. J. Murphy and also by Mr. E. Jona in the *Electrician* of April 28th. Though more elaborate in design than the comparatively simple "search coil" of Gott's fault-finder, they both, on account of their increased sensitiveness, possess greater certainty in indicating the time when a fault, showing no outward evidence of its existence, passes into the tank during picking up.

A single fault of moderately low resistance, *i.e.*, not exceeding a few hundred ohms, does not as a rule present any great difficulty, since its near presence, as the ship disturbs it on the sea bottom, and heaves it up in-board, is generally clearly manifested by a control test with the distant end free, and employing one or two constant (Daniell's) cells, or by observing on a Sullivan dead-beat galvanometer any sudden change and unsteadiness in the cable current caused by the fault. In the case, however, of a high-resistance fault, especially in a long cable disturbed by earth currents, there is often great uncertainty, so that a really reliable method would be an important assistance to cable electricians, and, by preventing unnecessary cutting, economise both time and cable.

The Murphy and Jona methods have a special value when more than one fault of low resistance exists in the cable, and to meet this case some more certain plan than the Gott search coil, or an ordinary insulation control test, is no doubt desirable.

Messrs. Jona and Murphy both increase the inductive effect by making use of four turns of cable on the picking up drum instead of the very short length of cable (less than half a turn) which influences the Gott search coil. There is also this important difference, that in the latter method the cable forms the primary and the search coil the secondary circuit, whereas in both of the two methods which we are about to describe the cable forms the secondary coil and has a current induced in it every time the iron drum is rendered magnetic by closing the primary coil attached to it. In these methods the primary coil admits of a large number of turns, and is, therefore, powerfully energised by a local battery of accumulators, and produces in the secondary (cable) circuit currents of sufficient strength to effect the object required. Before, however, losing sight of our old acquaintance the "search coil," which has done useful service as the pioneer instrument and in directing the attention of others to the same subject, it should be noted that although the primary (cable) circuit is short, its effect is multiplied considerably by the large number of turns in the secondary coil, and it has the merit of simplicity. Again, when two or more shore ends lie close to each other, this "search coil" instrument is serviceable for detecting intermittent currents sent through the faulty cable from the shore station when the supposed defective one has been heaved up on a boat for under-running towards a fault, and thereby certifying whether the particular one raised is that required, and whether the boat is inshore or seaward of the fault. For this particular purpose it is more simple, and, probably, more suitable than the Murphy or Jona device, even if the two latter methods can be made applicable for boat work.

In the Jona design, fig. 1, the wires of the primary coil are made to lie parallel with the turns of cable by affixing a reel, B B, to the drum, T, by means of angle irons riveted

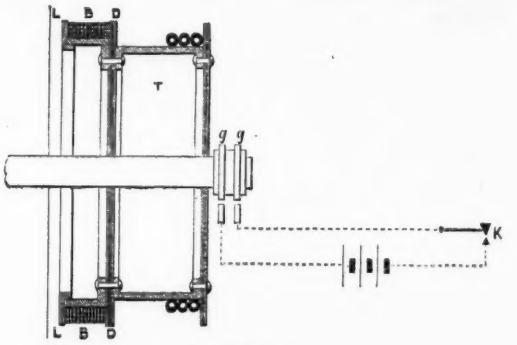


FIG. 1.

upon the disc, D, and terminated by a bronze ring, L. On the reel is wound an insulated wire with the ends connected to metal rings, *g g*. Two brushes, joined up with a set of accumulators and an interrupting key, K, make continuous contact with the rings, *g g*, as the drum revolves.

Fig. 2 represents a cable being picked up into a tank, V, by the drum, around which are the turns of cable. The end in the testing room is connected through a galvanometer to earth, either directly, or preferably with a condenser intervening, and the other end at the shore station is also to earth through the speaking instrument. When under these conditions the key is closed, the magnetism developed by the primary coil in its iron core, represented by the drum, produces in the turns of cable, C, an induced current, which may be observed as a throw on the galvanometer, S. While the fault is in the sea, the whole of this momentary induced

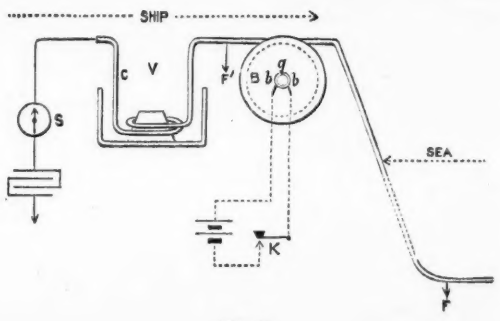


FIG. 2.

current passes through the galvanometer, but on the fault arriving abaft the picking up drum its resistance no longer forms a shunt on the unrecovered portion of cable and the speaking apparatus at the distant station, and consequently the total resistance in this direction is increased, while at the same time the fault becomes a derived circuit with the galvanometer, S; hence, on again closing K, the induced throw on the galvanometer is decreased, *as a rule*, sufficiently to indicate that the fault is in-board. When tried on the Assab-Perim cable in 1898, the reel, B B, had 650 turns (3,250 metres of copper wire), giving a resistance of about 40$^{\omega}$, and insulated with paraffined cotton. The battery consisted of 35 accumulators, the condenser of 30 microfarads, and a Sullivan galvanometer was employed with a coil of 1,000$^{\omega}$. On this occasion the fault had a

resistance of about 28$^{\omega}$, and it was distant from Perim about 38 miles. In this case the galvanometer throws, when the fault was forward of and abaft the drum, are not stated; but, on another occasion, when turning over cable from one tank to another, and experimenting with artificial leaks,

A fault of 100$^{\omega}$ gave 166 divs. when forward of the drum, and 20 divs. when abaft the drum.

Another 500$^{\omega}$ gave 150 divs. when forward of the drum, and 60 divs. when abaft the drum.

The *difference* in the throws with a high resistance fault would evidently be much smaller, and therefore not easily distinguishable, even when the galvanometer is very sensitive and well balanced, and it is unfortunately this kind of fault which really presents a difficulty as before noticed.

Mr. Jona points out that when, working from one tank to another with artificial faults, the fault passed the drum, the galvanometer deflection sometimes increased instead of diminishing. There is therefore some uncertainty, even when dealing with comparatively low resistance faults, as to the effect to be expected when the fault gets abaft the drum.

Some interesting figures are given resulting from experiments to determine the influence of the cable sheathing and of the brass tape over the core. The conditions appear to have been as follows:—

	Throw.
1. Four turns on the drum of cable having a 130/130 (not brass taped) sheathed with 10 No. 6 iron wires	116 divs.
2. Four turns on the drum of cable having a 130/130 (brass taped) sheathed with 10 No. 6 iron wires, ends of brass tape free	108 „
Four turns on the drum of cable having a 130/130 (brass taped) sheathed with 10 No. 6 iron wires, ends earthed through the sheathing	108 „
3. Four turns on the drum of bare core, 130/130 ...	133 „

Mr. Jona finds that the sensitiveness is much increased by cutting out the condensers and connecting the galvanometer to earth through a convenient resistance. For this arrangement he employs a coil of low resistance (50$^{\omega}$), and the cable current is balanced against that of a battery, or, better still, by torsion on the suspension. Owing, however, to the difficulty of keeping the *spot* within the limits of the scale, it is, he finds, nearly always preferable to use a condenser of large capacity. He also considers it certain that if the disc D were of bronze instead of iron (to diminish magnetic leakage) a still greater sensitiveness would result.

Mr. Murphy's arrangement, illustrated in figs. 2A, 2B and 3, is likely to prove the more sensitive device.

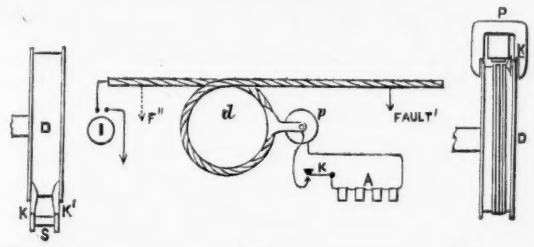


FIG. 2A. FIG. 2B. FIG. 3.

Fig. 2A.—D, drum. Fig. 2B.—I, Instrument; *d*, drum forming core to secondary (cable) turns; *p*, primary coil; K, interrupter; A, accumulator. Fig. 3.—P, primary coil and core; K, knife; D, drum and cable turns (secondary), action same as fig. 2.

The idea of having four turns of cable on a thick short cylinder, magnetised by a strong primary coil encircling a portion of it, although marking a great advance, did not commend itself to Mr. Murphy as entirely satisfactory. The expedient he resorts to appears to have decided points in its favour, both on the score of efficiency and simplicity of construction.

The cable drum of the Eastern Telegraph Company's cable ship *Electra*, on board of which Mr. Murphy's first experiments were made, is furnished with two "knives," K K′ to fleet the cable along the drum and so clear a way for on-coming turns, and these knives are connected by a shaft, S (fig. 2A).

On this shaft he coils his primary wire, thus forming what is practically a *transformer* with the four turns of cable on the drum as the secondary coil. On board the *Amber*, where experiments were subsequently repeated, the position of the drum knives did not lend themselves to the same arrangement, and it became necessary to apply a large magnet to the drum as shown in fig. 3.

With this latter arrangement some good results, we are told, were obtained when experimenting with artificial faults of 5,000$^{\omega}$ to 10,000$^{\omega}$; so that, although, as Mr. Murphy remarks, not sufficiently tried in practice to justify its being definitely pronounced a success, it certainly looks promising.

The idea, as in Mr. Jona's method, is that while the fault remains in the sea the currents in the turns of cable on the drum exert their full influence on the testing room instrument, while as soon as the fault passes abaft the drum the *leak* is removed from the submerged portion of cable and forms a shunt on the instrument, the result producing a noticeable change, see fig. 2B.

What this change amounted to in the case of the faults referred to, or what instruments were employed, is not stated. It does not, however, seem likely that the difference resulting from the two positions of such high resistance faults with regard to the drum could be very decided, but if sufficiently so to give unmistakable indications of even much lower resistance faults than these arriving abaft the drum, the method is likely to be of great assistance when picking up cable during repairs. In a factory we have already sensitive means of detecting very high resistance faults in *core*, as for instance, Warren's test and other modifications of it; or running the insulated core through a trough of water connected to earth and noting the change in the galvanometer deflection when the fault passes through the water; so that for this purpose there probably is not much scope for improved methods. For faults of moderate resistance in a sheathed cable a loop test should give the position very closely, and, while turning over to it, an insulation test, with a strong current on one end of the section and with the other end free, is generally disturbed sufficiently when the fault reaches the drum to indicate the exact position. Noting a disturbance in the same way when turning over in the factory, even when the fault resistance is too high for a satisfactory loop test to indicate its approximate position, would probably be as reliable at least as either of the induction methods under discussion; but in the case of old cable, with several faults in it, Mr. Murphy's or Mr. Jona's plan might prove useful if the turning-over drum be specially constructed for use in a factory, so as to obtain the most favourable conditions for developing strong secondary currents in the turns of cable. For instance, wrought-iron would be a decided improvement on the cast-iron drum of the picking-up gear.

Mr. Murphy propounds the following questions:—

1. Should a condenser or resistance be added to the testing room end of the cable to enhance the shunting power of the fault?
2. Should the further end of the cable be freed or earthed?
3. Should the inducing currents be of very low or high frequency?
4. Is a galvanometer or a telephone the better indicator?
5. If the former, will a secohmeter, by causing the galvanometer throw to be cumulative, be useful?
6. If a high frequency is desirable, will a Wehnelt interrupter do?

Without going into the relative merits of these alternative considerations, we venture to think that at any rate for high resistance faults the following conditions would probably be most sensitive and suitable for all lengths of cable, and whether there be one or more faults in it. A vibrator in the primary circuit, a telephone as the testing room indicator in the secondary (cable) circuit, no condenser between the testing room indicator and earth, and the distant end of the cable free.

A simple vibrator seems all that is absolutely necessary, though a Wehnelt electrolytic current interrupter, if not of too high frequency, would have the great advantage of working noiselessly. Experiment would, of course, be the best guide as to the frequency most suitable to a transformer, in which the nature of the iron of the picking-up drum plays so important a *rôle*.

A condenser would no doubt be desirable if a *galvanometer* be employed, both on account of earth currents and polarisation set up by the fault. Moreover, the turns of picked up

cable in the tank give rise to constant undulatory currents, and a shunt would render the galvanometer less sensitive, so that it seems clearly advantageous, in both the Jona and Murphy method, to employ a telephone with an interrupter producing intermittent currents (of greater or less frequency as experiments prove desirable), which will not be affected by the slowly changing waves referred to, and to use no condenser. The condenser may, however, be introduced if the high resistance of the fault and capacity of the cable should render it necessary, but this will probably not be the case.

NOTE ON THE HEATING OF COMMUTATORS.

By H. W. W. DIX.

Messrs. Parshall and Hobart have given some interesting figures for estimating commutation losses, in their articles on "Electric Generators," which appeared recently in *Engineering**. The heating of commutators is chiefly due to the contact resistance of the brushes, and to the friction produced by their rubbing on the commutator. The heat produced by friction (expressed in watts) being added to the C^2R loss, the authors state that if the cooling surface of ordinary unventilated commutators is proportioned on the basis of 2 to 2½ watts per square inch, the temperature rise will be 40° C. in the case of the smaller, and 50° C. in the case of the larger figure.

The old method of deciding the size of commutators by making them large enough to take a certain number of brushes whose aggregate area, at the point of contact, is sufficient to carry the total current at a density of about 160 amperes per square inch is misleading, as the neglect of any allowance for friction would, in many instances, cause overheating, especially in the case of commutators running at high peripheral speeds. The current density at the point of contact with the commutator makes, however, a useful check calculation; it may be 140 amperes per square inch for large brushes, say, 2 inches × ¾-inch to 2 inches × ½-inch, and as high as 200 amperes per square inch for smaller brushes, say, about 2 inches × ¼-inch.

It is desirable to make commutators and brushes as small as possible consistent with good working, and the object of this note is to suggest a method of determining readily the most economical size of both, to suit any given set of conditions. If

A = total area of the + brushes in square inches.
A_E = most economical area of the + brushes in square inches.
k_1 = contact resistance in ohms per square inch.
μ = coefficient of friction.
k_2 = a constant = 22.
p = brush pressure on commutator in pounds per square inch.
V = peripheral speed of commutator in feet per minute.
W = $C^2 R$ + friction lost over commutator, viz., total watts lost.
C = amperes carried by commutator.

$$\text{Then copper watts} = \frac{2 k_1 C^2}{A},$$

$$\text{Friction watts} = p A \mu V \times \frac{2 \times 746}{33{,}000},$$

$$= \frac{p A \mu V}{k_2}$$

$$W = \frac{2 k_1 C^2}{A} + \frac{p A \mu V}{k_2}. \qquad (1)$$

Taking the figures given by Messrs. Parshall and Hobart,

$k_1 = \cdot 003^{\omega}$ for copper brushes,
$k_1 = \cdot 03^{\omega}$ for carbon brushes,
$p = 1 \cdot 25$,
$\mu = \cdot 3$,

and inserting the values and reducing

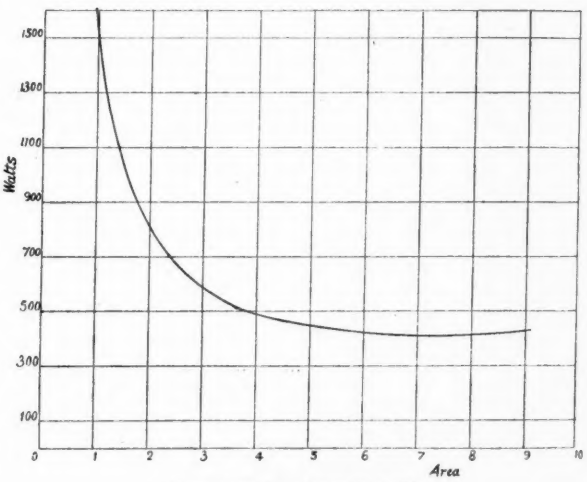
$$W = \frac{\cdot 006\ C^2 + \cdot 017\ A^2 V}{A} \text{ for copper brushes,}$$

$$W = \frac{\cdot 06\ C^2 + \cdot 017\ A^2 V}{A} \text{ for carbon brushes.}$$

Returning to equation (1) and differentiating and equating to zero, we find that the watts lost, and consequently the dimensions of commutator, become a minimum when

$$A = C \sqrt{\frac{2 k_1 k_2}{V \mu p}}. \qquad (2)$$

This value for A is, however, not the best to employ, as it is inconveniently large.



Revs. 800, Amps 500, V. 1,680.

Referring to fig. 1, which is the curve connecting W and A, C and V being constant, we see that as A is increased from a small value, the watts lost decrease very rapidly at first, and then slowly round the sharp bend in the curve until the minimum value of W is reached. After this the watts begin to increase. It will be best then to choose our brush area on the bend of the curve, as beyond this an increase in brush area only produces a slight decrease in the watts lost. Choosing half the value of A as given by equation (2) as the best,

$$A_E = \frac{C}{2} \sqrt{\frac{2 k_1 k_2}{V \mu p}}.$$

Inserting the values previously given for the constants,

$$A_E = \frac{C \times \cdot 297}{\sqrt{V}} \text{ (copper brushes).}$$

$$A_E = \frac{C \times \cdot 936}{\sqrt{V}} \text{ (carbon brushes).}$$

The watts lost with the most economical brush as thus defined are—

$$W = \cdot 0252\ C \sqrt{V} \text{ (copper brushes).}$$

$$W = \cdot 08\ C \sqrt{V} \text{ (carbon brushes).}$$

With the aid of these four last expressions the size of brushes and dimensions of commutator can be rapidly decided on.

CAPACITY MEASUREMENT OF SUBMARINE CABLES IN CONNECTION WITH THE K R LAW FOR SPEED OF SIGNALLING.

It is unfortunate that the discussion of Mr. Elton Young's paper at the Institution of Electrical Engineers should have been crippled, and the important questions of the accuracy of the K R law, and a suitable measurement of capacity for speed calculation, left in obscurity by the haste with which it was rushed to a conclusion.

* *Engineering*, July 8th, 1898.

This arose from the evident desire of the chairman to keep the discussion within as narrow limits as possible, in order to make room for another paper on the agenda, and also in some measure from what appeared to be a slowness to appreciate fully the real scope of the subject in all its bearings. This only would account for the apparently partial, though unintentional, treatment dealt out to individuals desirous of joining in the discussion.

For example, Mr. Alex. Siemens, recognising the direct relation of capacity measurement to the speed of signalling through cables, asserted that the great problem which cable manufacturers had before them was to reduce the "spongy capacity," as he is pleased to designate *absorption*; and that this was possible was clearly demonstrated (so he affirmed) by the table of *actual* and *estimated* speeds of Atlantic cables—see ELECTRICAL REVIEW, June 3rd, 1898, p. 786, and also reprint in *Electrician*, May 12th, 1899, p. 91.

How very important it was to pay attention to this "spongy" factor of the capacity might be seen by comparing the speed of working the 1894 "Anglo" and 1894 "Commercial" Companies Atlantic cables as given in that table. Although Mr. Siemens had been permitted to draw what we consider to be an erroneous comparison between the cable made by his own firm and that constructed by the Telegraph Construction and Maintenance Company, Mr. Willoughby Smith was precluded from traversing statements which would speedily find their way into print by the chairman remarking that he did not think it necessary for a speaker to answer another on a matter which was not relevant to the paper. The consistency of this ruling became even more inscrutable when Mr. Murphy later on freely discussed this question of absorption in its bearing on speed, and pointed out the unsound basis on which the alleged disparity between the "Anglo" and "Commercial" 1894 cables had been founded by Mr. Siemens. It was rendered less apparent still when the chairman himself referred to the importance of Mr. Heaviside's suggestion that the effect of self-induction of the copper conductor on speed could not be neglected; and then added, that signalling was now becoming more and more a matter of waves, and the nearer we got to signalling with alternating currents the further did we get away from the strict application of the K R law; and the more important was it to take into account capacity, absorption, and self-induction. It would appear that the chairman, though at first anxious to exclude the question of *speeds* as not relevant to the scope of a paper on capacity measurements, had, owing to the persistent reference of one member after another to the speed aspect of the subject, himself become impressed with its direct bearing, and, unable to stem the flood, allowed himself to be borne along with it, leaving Mr. W. Smith stranded high and dry with the comforting assurance that a time would come when, if he sent some remarks to the secretary with a request that they should be printed in the *Journal*, the council would be willing to take them into consideration. In the meantime Mr. Siemens's misleading comparison remained unanswered—though not unchallenged—by one of the members most interested.

The question of *absorption* is clearly one worthy of careful consideration, in view of the opinion expressed by several members that the K R law is not strictly applicable to very long cables.

How far this law is incompatible with practical results is a question which should be settled with as little delay as possible, in view of the fact that unusually long sections are projected for spanning the Pacific. After the claim set up by Mr. Siemens that speed has been largely increased by strict attention to the absorption factor in capacity, it is certainly desirable that this should be verified by a comparison of *the same words* made on the two cables referred to, under conditions as to battery and signalling condensers which will give a maximum of speed for, as nearly as can be judged, the same size and definition of signals when employing the *same* automatic transmitter and recorder instrument for both cables, and that specimen slips should be published.

Owing to the effect of the inertia of the coil, and the E.M.F. set up in the coil by its movements in a strong magnetic field, on signals—which latter effect, as Mr. Taylor pointed out, is more marked as speed is increased—the two different speeds of working through the two cables, in order to produce the same result, cannot be accepted as *absolutely* correct, but we should know what the relative speeds really are, and be able to judge whether any departure from the K R law—if noteworthy—can be wholly accounted for by the inertia of the coil referred to. If it can, the advantage of employing an *Ader* or other instrument, with a light suspension, whose movements may be photographed, and whose inertia being negligible does not introduce an error dependent on speed, would be all the more apparent. If, on the other hand, the whole difference in the speeds cannot be attributed to inertia, before concluding that the K R law is inapplicable—of which fact we have at present had no reliable or convincing evidence, though the difference in the self-induction of two cables probably does affect speed calculations in *some* degree—it must first be decided whether the way in which the capacity, K, is measured, is suitable to the speed formula, and to what extent, if at all, the absorption factor of the whole charge taken up by a cable should enter into the capacity value to be used. In other words, what is to be taken as the correct capacity of a cable for signalling purposes, and how is absorptive effect modified by speed of working? Mr. Siemens says that by paying careful attention to it a very important increase of speed has accrued. Mr. Taylor also thinks that while the *instantaneous* value obtained by Mr. Young's method may well be taken as a basis for calculating capacities *for the localisation of faults*, for *signalling* purposes it is not the true capacity. In this connection it is, he says, impossible to dissociate the three factors—instantaneous charge, absorption, and leakage—which go to make up the *working* capacity; and it seems that a K R value, based on an instantaneous value of K would not be a true one, since, if applied to the working speed of a cable, it would give a higher rate than would be obtained in actual practice. If, however, the value of K be a true one, it seemed that K would vary with speed. In connection with this opinion, we would point out that for *signalling* purposes the third factor—leakage—may, at any rate, be dissociated from instantaneous charge and absorption. As the latter is rapid at the moment of making key contact, and for the first second or two, it seems evident that this quantity must in *some* measure enter into the calculation of speed, and to this extent Messrs. Siemens and Taylor's contention would be correct; but the question is, Is this quantity important, or practically negligible?

In opposition to the above view, Mr. Murphy argues that if the rate at which gutta-percha absorbs and gives up its residual charge is a slow one, any slight change that Messrs. Siemens may have been able to make in the "spongy" quantity of their cores would have little effect on the speed of their cables. The importance of the points raised is evident, and we are glad that the exclusion of the speed of signalling was not persisted in, though, doubtless, the discussion might have led to more definite conclusions on the subject of capacity had more time been allotted and members encouraged to air their views freely. With regard to the speed of working cables, there is clearly required a more exhaustive inquiry into the following points:—

1. To what extent does absorption enter into the *working* capacity for calculating speed?

2. What is a suitable correction for self-induction in cable conductors of different forms?

3. What is the best method for measuring K, including absorption, for very short intervals of time required for signalling at different speeds, which will be unaffected by the leakage factor?

4. What revision is required in the formula for calculating speed in order to include the difference in the self-induction of the two cables compared?

Since writing the above we notice that Mr. W. Shuter, managing director of the Telegraph Construction and Maintenance Company, points out inaccuracies in calculating the table of relative speeds through the Atlantic cables, published by Messrs. Siemens Bros., and referred to above, and also "that with regard to the actual speed obtained in regular working Messrs. Siemens base their calculations for one of the T. C. and M. cables upon the speed (by hand sending) given in a report 22 years ago. Much more recent figures were available. For instance:—The carefully timed counts made on the 'Anglo' company's cables published in the *Electrician* of November, 1894, show a speed of about 50 per cent. higher than the earlier figures. On the other hand, the working speed of the 1894 'Com-

mercial' cable laid by Messrs. Siemens is given in the table as 40 words in regular work. Mr. G. G. Ward, vice-president and general manager of the Commercial Cable Company, in a letter to the T.C. and M. Co. (July 11th, 1898) gives the speed of this cable as 32 words; while Mr. F. Ward, the manager in England of the same company, in his evidence before the Pacific Cable Committee (November, 1896), stated that, under pressure, they could work up to 34 words per minute. It is a far cry (Mr. Shuter remarks) from either of those speeds to 40 words per minute credited to this cable by Messrs. Siemens."

Until more reliable speed trials have been made on both cables under comparable conditions, it is, to say the least, premature to call in question the accuracy of the K R law.

LEEDS CITY TRAMWAYS.*

We give below detailed statements of the receipts and expenses of the tramways of the Leeds Corporation for the year ended March 25th, 1899. It is scarcely necessary to remind readers that the Corporation are at present working cars by horse, steam, and electric traction, although the latter method will as soon as practicable be applied to all the lines. Meanwhile the accounts for the different sections are kept distinct, and afford most interesting and important criteria. The actual working expenses on the three systems, exclusive of allowances for depreciation, will be seen to be as follows:—

Working expenses per car mile—	
Electric cars	4·42d.
Steam cars	9·36d.
Horse cars	9·44d.

The detailed figures, which are now published for the first time, are as follows:—

Return Showing Receipts and Working Expenses for Year ended March 25th, 1899.

Electric Tramways.

Total electric car receipts	£48,032 15 0
Total mileage	934,368 miles.
Receipts per mile	12·33d.
Working expenses	4·83d.

Analysis of Working Expenses.

	£	s.	d.	Expenses per mile.
Drivers' wages	4,201	0	9	1·07d.
Conductors' wages	3,149	9	8	·80d.
Generating station expenses—	£	s.	d.	
Depôt men's wages	951	9	10	
Oil	90	1	10	
Coal	1,098	3	7	
Sundries	278	1	7	
	£2,417	16	10	
Less amount from lamp committee	456	5	0	
	1,961	11	10	·53d.
Battery station expenses	142	8	11	·03d.
Electric car shed expenses—				
Repairs and car maintenance	1,407	8	7	·37d.
Car washers and depôt men	1,814	9	7	·46d.
10% depreciation on motor and trail cars	1,625	12	0	·41d.
Electrical engineers' salaries	445	16	2	·11d.
Road maintenance (proportion)	1,100	0	0	·28d.
Compensation, damage, and personal injuries	358	5	2	·09d.
Management and general expenses (as per detailed statement appended)	2,599	10	8	·67d.
Office rents (one-third)	55	0	0	·01d.
	£18,860	13	4	*4·83d.

Cost of generating current, per Board of Trade unit ... ... ·60d.

(* This does not include interest on capital and sinking fund, or depreciation on electrical plant other than cars.)

Total Miles Run by Electric and Trailer Cars.

Motors	816,749
Trailers	*117,619
Total miles	934,368

The consumption of current per motor car mile is ·960 units.
The consumption of current for each trailer car mile is ·480 units.

Details of Mileage.

Motor cars	816,749
Trailer cars (mileage taken as ½)	*58,809
Total miles at ·960 units per mile	875,558

Total generating station expenses, as stated above, £1,961 11s. 10d. = ·53d. per mile.

Halve the trailer mileage and add to the motor mileage, and reckon the total at ·960 units per mile.

Number of Units Generated for Year, March 25th, 1899.

Total units for year ended March 25th, 1899	809,101
Less supplied to arc lamps during year ended March 25th, 1899	32,660
	776,441

Total cost, £1,961 11s. 10d. = ·60d. per unit.

Steam Tramways.

Steam car receipts	£23,603 1 8
Total mileage	479,775 miles.
Receipts per car mile	11 80d.

Expenses as per Revenue Account.

	£	s.	d.	Expenses per car mile.
Repairs	4,849	15	2	2 42d.
Fuel	2,597	8	2	1·29d.
Drivers' wages	2,989	9	1	1·49d.
Conductors' wages	2,352	19	1	1·17d.
Rent of depôts and offices	216	5	0	·10d.
Engine boiler insurance	47	5	6	024.
Compensation, damages and personal injuries	601	9	6	·30d.
Maintenance of roads (proportion)	500	0	0	·25d.
" cars	2,045	5	7	1 02d.
Depreciation on cars	607	5	0	·30d.
" engines	1,350	0	0	·67d.
Management and general expenses	2,599	10	7	1·30d.
Total expenses	£20,756	12	8	*10·33d.

* Exclusive of interest on capital or sinking fund charges.

Horse Tramways.

Horse car receipts	£40.436 0 4
Total mileage	989,320 miles.
Receipts per car-mile	9·80d.

Horse Haulage—Expenses as per Revenue Account.

	£	s.	d.	Expenses per car mile.
Horse keep, &c.—Corn, hay, and bran	14,284	6	4	3 46d.
Bedding	592	0	2	·14d.
Wages	4,505	13	0	1·09d.
Utensils and sundries	280	15	3	·06d.
Horse shoeing and veterinary services	1,526	7	10	·37d.
Drivers' wages	5,089	11	3	1·23d.
Conductors' wages	4,247	16	6	1·03d.
Foremen and tip boys' wages	1,183	9	8	·28d.
Rent of stables and offices	582	3	0	·13d.
General repairs to depôts, &c.	445	19	7	·11d.
Gas and water	422	10	7	·11d.
Compensation — damage and personal injuries	333	4	3	·08d.
Maintenance of roads (proportion)	242	18	1	·05d.
" cars "	2,045	5	8	·49d.
" harness "	349	10	1	·08d.
Depreciation on cars	607	5	0	·14d.
Management and general expenses (proportion)	2,599	10	7	·63d.
Horse renewal or depreciation account	2,857	10	0	·69d.
Total expenses	£42,195	16	10	10·17d.

Exclusive of interest on capital or sinking fund charges.

Details of Management and General Expenses.

Rates	£1,627 11 8
Licenses	149 16 0
Insurance (buildings)	58 9 4
Taxes (income)	228 11 8
Salaries (office)	1,540 5 7
Salt, gravel, &c.	897 0 8
Printing, S. & A.	337 3 2
Drivers' and conductors' suits, &c.	946 2 3
Inspectors', &c., wages	1,964 17 6
Electric light	48 14 0
Total for whole system	£7,798 11 10
Proportion (⅓) to horse, steam and electric	£2,599 10 7

A comparison of these figures gives a convincing proof of the claims advanced by advocates of electric traction that the electric

* The *Railway World*.

service, as compared with horse or steam, is not only the most popular system with the travelling public, but is also the most economical in working. The fact must, however, be borne in mind that the electric section of the Leeds tramways undertaking has the great advantages of a fairly level route throughout its seven miles of double track and of running through the centre of the city, with a popular holiday resort at e ther end, and a thickly populated district almost the entire length of the line, whilst the horse and steam sections have to deal with the heaviest gradients, and on many routes a much thinner population. The horse cars average 26 passengers per car, as compared with the electric cars 51, and steam cars 56, hence the comparatively small earnings of 9·80d. per car mile. The steam cars, from their great age, necessitate a very large expenditure in repairs and maintenance. The Tramways Committee, in view of the ultimate extinction of steam for tramway haulage, are naturally loth to invest in new engines, but in the transition period are obliged to keep them running for the public convenience.

Another fact that should be noted is, that whilst the horse and steam sections have been debited with the usual charges for depreciation, the electric section, beyond a solitary charge of 10 per cent. on the cost of the motor and trailer cars, has not been charged with anything under this head, the Committee not having as yet sufficient evidence to guide them on this very important point.

No interest or sinking fund charges are included in the account set out above. The electric system will of course have to bear the larger proportion of these items owing to its proportional larger initial cost; but, after paying all expenses as enumerated above, and providing a sum of £10,415 7s. 9d. for interest, and £9,302 11s. 4d. for sinking fund charges on the general undertaking, there remains a surplus on the year's accounts of £12,030 14s. 10d. There can be no doubt, after comparing the working costs and receipts of the three systems, that the introduction of electric traction in Leeds has fully justified the courageous policy of the Tramway Committee of that enterprising city.

LEGAL.

TUDORS, MASH & CO., *v.* HEADLAND'S PATENT ELECTRICAL STORAGE BATTERY COMPANY, LIMITED, AND WALKERS, PARKERS & CO. (THIRD PARTIES)

MR. JUSTICE MATHEW, in the Queen's Bench Division on Friday last, delivered judgment in this case. The facts sufficiently appear from the judgment. His Lordship said the action was brought to recover the price of certain chemical materials supplied by the plaintiffs to the Headland's Patent Electrical Storage, &c., Co. The defendant company counterclaimed for damages against the plaintiffs for damage occasioned to them by reason of the defective character of some of the materials supplied to them by the plaintiffs. The plaintiffs obtained the articles in question from Walkers & Co, who were cited by the plaintiffs as third parties, the plaintiffs proposing to transfer to them any liability that they might have incurred in the matter. It appeared that the defendant company was formed to work a patent of Mr. Headland's for electric storage batteries, and they obtained a large order to supply the electric storage batteries to a barge at Birkenhead, which was intended to be the motive power of the barge. The defendants had dealt with the plaintiffs in litharge for a considerable time, and the patentee had also dealt with them, and had obtained goods of a proper quality. A complaint arose with respect to the litharge which had been supplied by the plaintiff company to the defendants, and which was obtained by the plaintiffs from Walkers & Co. The litharge was used in the following way:—The electric storage batteries consisted of a number of cells on which were placed positive and negative plates, each cell containing 29 plates, 14 positive plates and 15 negative. When the plates were prepared they were prepared by being covered with a paste of litharge and sulphuric acid. The positive plates were covered with red lead and placed in position immersed in sulphuric acid, and currents of electricity were passed through the plates, and if the apparatus worked satisfactorily the negative plates were converted into a spongy lead and the positive plates were uninjured. In that way electricity was stored as was intended to be used as a motive power. On October 28th, 1896, the defendants having obtained this order applied to the plaintiffs to supply them with the litharge they required, and their order was for litharge of the very best quality. The plaintiffs passed on the order to Walkers & Co, who had also been old customers of the plaintiffs. The litharge which had been supplied to the plaintiffs, some of which had gone to the Headland's Company, had previously been of an entirely satisfactory kind. When the litharge in question was supplied, steps were taken by the Headland Company to prepare their apparatus at their works at Leyton, and when the litharge had been applied to some of the plates, it was noticed by Mr. Headland that there was apparently something wrong, and he sent two plates to the plaintiffs, one a pink plate considered to be satisfactory, and the other white. Upon the plates being sent to the plaintiffs, Mr. Mash saw a representative of Walkers & Co., and it was clear that at that interview that Walkers and Co. were informed—what it was said they were not told before—that the litharge was applied for electric purposes, and that there was this complaint, with reference to which Mr. Mash could say nothing. The result of that interview was, Mr. Mash was reassured that the litharge supplied was of the best quality and that the difference in colour meant nothing, but it was stated that fanciful people preferred one kind of litharge for electrical purposes to another, and it was said that if the defendants would send back the last two casks of litharge supplied they would supply others in their place. It turned out that the last two casks returned contained absolutely pure litharge, and if there was anything which was wrong with the litharge it must have been in the previous deliveries. His Lordship said there was evidence before him to satisfy him that at Leyton again there was something wrong with many of the plates, and a large number of them were rejected by Mr. Headland. These were replaced, and other plates were prepared with the litharge in the way mentioned, but their condition was not satisfactory to Mr. Headland, and he replaced them with others. The whole of the group of plates were sent down to Birkenhead. The plaintiffs' attention was called to the defects that were discovered, and they were invited to make any inspection they thought fit. It was strongly urged upon them that they should do so. Unfortunately, no such inspection took place. It was not the first complaint that was made on the subject. In April and May there had been a correspondence between the defendants and the plaintiffs, and passed on to Walkers & Co., in which it was stated in the clearest possible way that there was something wrong with the plates which had been delivered. Experiments had been made at Birkenhead with the motive power of the apparatus, and it was shown that for short trips the electric energy was sufficient, but for long trips it was insufficient. Every plate was constantly charged, but there was something wrong, and the power could not be obtained, and after a long consideration at Birkenhead it was decided that the whole apparatus should be sent back to the works at Leyton, when it was discovered that out of a large number of negative plates 300 of them were perfectly useless, and found to be white, and incapable of receiving the full effect of the current of electricity, and the current passed on to the positive plates had the effect of rotting them. The conclusion arrived at was that the negative plates being defective by reason of the impure condition of the litharge, the current of electricity did not have the effect it ought to have had, and the effect of charging to obtain the necessary efficiency of the negative plate was to pass it on to the positive plate, which was practically destroyed for all ordinary purposes. The Headland's Company then took steps to have properly prepared litharge, and it was now said that the apparatus worked properly. Notwithstanding the complaints of the Headland's Company, the plaintiffs brought the present action for the amount of their claim, and the defendant company counterclaimed for the damage alleged to have been done to them. At the time the counterclaim was originally framed, and particulars of damage furnished, it was by no means clear how the breakdown of the apparatus was to be accounted for, but steps were taken by the defendants to have the litharge supplied to them by the plaintiffs analysed, to ascertain if there was anything wrong with it. On the other hand, the two plates his Lordship had mentioned—the pink and the white plates—were made the subject of examination and analysis on the part of the plaintiffs. The controversy between the parties was how this defect, which was admitted to exist in the negative plates, was to be accounted for. A gentleman of the highest possible character as a chemist, Mr. Ballantine, was applied to by the Headland Company to examine negative plates. For the purpose of his analysis he had furnished to him a plate which was said to have done its work fairly well, two which were said to be entirely defective, and a fourth that had not been used. As a result of his analysis Mr. Ballantine came to the conclusion that the defect in the negative plates was due to the presence of carbonic acid in the litharge. There was also a large proportion of sulphate of lead, and experiments he conducted showed that the presence of the carbonic acid was what had so sterilised and damaged the negative plates that the apparatus broke down. Mr. Ballantine agreed with the witnesses called for the defendants on one point. When the sulphate of lead was pointed out as being in large quantities in the defective plates attention was also called to the fact that it appeared in the good plates as well. Mr. Ballantine explained that sulphuric acid had a tendency to drive off carbonic acid, and in the good plates probably that operation had been chemically performed and this accounted for the result. That being the condition of things, and this carbonic acid having been discovered in the plates, the case originally made by the plaintiff was that the carbonic acid had been absorbed by exposure. It was agreed that exposure would have a tendency to attract carbonic acid if it took place for a sufficient length of time. The evidence on the head of exposure was of a speculative character, and the evidence of Mr. Ballantine, on which he placed great reliance, was that he did not attribute the carbonic acid found to exposure after delivery of the goods by Walkers & Co. to the Headland Company. If the matter rested there he should have no doubt that this was impure litharge, and that however the impurity was contracted it was contracted before delivery to the defendants, and was the explanation of all that had been discovered to be defective in the apparatus. But there was an alternative case put forward on the part of the plaintiff and supported by some very valuable expert evidence. It was said that if exposure did not account for the presence of the carbonic acid in the litharge, then it was an entire mistake to say that the carbonic acid was the cause of what was discovered. It was due, it was said, to over-sulphating, and this over-sulphating it was contended was due to the improper way in which the paste had been made and from carelessness and want of skill on the part of the Headland's Company. The paste, it was suggested, had been over-sulphated, the result of which was that there was deposited over the plates a white coating, that that white coating was a non-conductor, and accounted for all the damage. As to that, there was no evidence whatever that the paste had been improperly made—indeed, the evidence was all the other way. It would be very hard to suppose that so simple an operation as making the paste—putting litharge and sulphuric acid together—should have been so conducted as to have produced results which would have been apparent immediately if there had been any improper management of the materials composing the paste. Besides, such a suggestion was quite inconsistent with the apparently casual nature of the defects which

were discovered. If there had been carelessness in making the paste, they would expect to have found it would have been of general application, and that it would have produced similar results throughout. But here, in a most capricious way, some of the plates were found to be all right, and such as would do their work properly, whilst others contained large quantities of carbonic acid, which would account for the defects. As a result of a careful consideration of the whole evidence, his Lordship said he was satisfied that the litharge, when it was delivered by Walkers & Co. to the plaintiffs to be by them delivered to the defendants was impure. He was satisfied, further, that Messrs. Walkers & Co. were aware that the litharge was intended to be used for electric purposes, and that they were responsible for the defects in the litharge. He had not examined critically the figures of the claim made by the defendants against Tudors, Mash & Co. Those figures would require very careful examination, because no more than the reasonable consequences of a breach of contract such as this could be considered in estimating the amount of damages. But this was a peculiar case and a very large undertaking, and it would, therefore, require very careful investigation to ascertain the precise amount in which the plaintiffs were liable to the defendants in respect of their breach of contract. He was also clear it would not be right to assume that the whole of the liability of the plaintiffs could be transferred to Messrs. Walkers & Co, because they were in a different position, and probably had much less information at the time the articles were supplied as to what use they were going to be put than had the firm of Tudors, Mash & Co. He hoped sincerely that without further investigation of the matter these two firms would be able to settle among themselves their respective liability, but if not the matter could be gone into before him at a future date. He hoped that both firms would bear in mind that any further investigation would probably be conducted at their expense, and might cost a deal more than such an investigation was worth. The defendants must have their costs from the plaintiffs, and the plaintiffs must have their costs from Walkers & Co. from the commencement of the proceedings up to the present time.

Judgment accordingly, that the plaintiffs on the claim and on the counterclaim Messrs. Walkers & Co. were held liable in damages for the defects in the litharge to the Headland's Company, the figures to be settled by arrangement, failing which, the matter again to come before his Lordship.

CORRESPONDENCE.

Electric Piping.

There seems to be a certain amount of ambiguity amongst architects and the general public as to which is the best and most economical method to instal the wires for the distribution of electric light throughout a house.

Whether it would be wise to use iron pipe, wood casing, twin lead-covered wire, single lead-covered wire, or concentric wire, depends entirely on whether the house is in the course of construction. A new house, newly painted and decorated, or a 50-year old house in fair order and nothing to be done in the way of cleaning, merely to instal the electric light with all its bridles and cross-beams to contend with.

It must become obvious from what has been said that the designer of any of the schemes must thoroughly know all about building construction, as well as having a thorough electrical knowledge. One well versed in the above must see at a glance that the material that lends itself to being impervious to moisture and impregnable, along with taking up the least possible space, to obviate the excessive raggling of single brick walls and joists, which becomes prohibitive from an architect's point of view, must necessarily be the system to adopt. But such a system is not applicable to all houses, as it is impossible to get iron pipes down the back of lathed walls without damaging the decorations unless we cut the pipes into short pieces and screw them, coupling them up as we push them down; as time is the essence of all contracts this becomes prohibitive, so that for a finely decorated house we must resort to a more flexible system, and as there are only four suited yet known, viz, twin lead-covered, single lead-covered wire, concentric wire, wood casing, along with compo pipe, so it should not be difficult to select the best suited for a concealed job.

Twin lead-covered wire and single lead-covered wire is hardly suitable, due firstly to the liberty taken with it in the way of being pulled about and stamped on by workmen with their heavy boots, and squeezing the lead almost hard on the conductor, also the excessive strain that is put on the wires in pulling them under the floors frequently fractures the insulation, along with the chance of the lead getting cut into by material in the deafening such as long nails, shells, pieces of glass, and sharp stones, which cannot be seen by the workmen, and can only make itself apparent by time and the difficulty in localising a fault on a twin system caused by vermin, nails, and sometimes decomposition through contact with other metals in moisture, and when such a thing takes place it invariably ends in disturbing the decorations. The writer has had a deal of trouble with lead-covered wire jobs, through, in many cases, bad workmanship in the way of scamping.

The same may be said about the concentric system with insulated outer, having a steel tape as a mechanical protection, which reduces to a minimum the chance of the cable being pierced, but does not get over the difficulty of locating a fault between; there are certain advantages in making the insulated outer carry the return current which need not be discussed here, and where there are a lot of switching, two and three-way, this system becomes very expensive, as the cable itself is very dear, and as it is only a question of time for the best material to come out.

A conduit system easily accessible and flexible is the system for a finished house, wood casing laid underneath the floors and composition pipe down the back of lathed walls to get to the light and up the back of door facings to get to the switch, and where the composition pipe enters the wood casing neat boxes are fitted, so enabling the contractor to pull in heavily insulated wires, leaving a screwed board at every box, thus making the system easily accessible at all times, and when it becomes impossible to get to some of the points without breakage of plaster, which is extremely rare, in fact, this is only the case when brackets are required and a neat tube or moulded cover can be run up the wall and decorated in accordance with the surroundings; it is not advisable to put a plug on the base and run a silk wire up to the point of light as the silk wire gets quickly dirty, and leaves a fearful mark on the wall.

This conduit system of wood casing and composition pipe has been wrought out in a good many finished houses in this town with great success providing the compo pipe is taken up in places where it is impossible for any person to drive nails in for fixing pictures on the system is absolutely safe, and can be fitted in with the least possible disturbance. This system is also applicable to old houses as to put in iron pipes mean the lifting of a great many flooring boards, the excessive raggling of joists and cutting of plaster and lathed walls, as one tries as much as they can to save the lifting of flooring boards, and consequently runs themselves into having to cut deep raggles in the joist for three or four pipes as the case may be, and subsequently shakes the whole structure, which invariably ends in re-doing up of the whole house.

For new houses in the course of construction there is nothing better suited than a specially prepared gas barrel pipe, rather lighter in the shell than ordinary gas barrel and perfectly free from burrs, we find the $\frac{3}{8}$ size the most suitable for branch circuits running into neat square boxes $6 \times 4 \times 1$ inch, invariably answers the purpose, with nice symmetrical bends and suitable rims put on the pipes from light to boxes, and from switch to box; if any water should gather, due to condensation, it will run into the box, and with a few $\frac{1}{4}$ holes bored in the bottom to allow the water to run into the deafening, and so save the wires from rapid deterioration.

The Simplex system is hardly suitable for large structures, where so much wet plaster, deafening, and cement is used, the water given off by each of them being full of sodium. The cement especially acting like a sponge when water is poured on it and eats into the iron pipe very rapidly, condensation takes place more rapidly in iron pipes when in cement, so any slotted pipe system does not lend itself so well for this class of work, and in my opinion is better suited for surface work.

With the insulated conduit system the external diameter of the pipe is too large, entailing an enormous amount of raggling, in fact, too much to be allowed by architects, and consequently becomes very costly to instal, also lending itself to scamping in the way of allowing lightly insulated wires to be pulled in and any partial earth cannot very readily be detected due to the insulation of the pipe, and, in my opinion, wherever a faulty wire crops up, the sooner it is removed the better, hence the reason for using prepared gas barrel free from burrs with heavy insulated wires, so that if any of the wires get damaged they will go to dead earth right away, the system being properly earthed instead of frittering away

inside the pipe, as it would do ultimately with the insulated pipe. I may add I have cut out iron pipes run solid with rust and wires together 8 and 10 years ago, hence the reason for having rims put on the pipes.

My belief is that a house is best served by having one large distributing board placed on the street floor, thus saving time and annoyance in localising faults. If the house is a very large one, then it ought to be broken up into sections, which can be best settled when one gets to know the requirements of the establishment.

J.

Edinburgh.

The Victoria Accumulator.

We herewith enclose an extract from a letter addressed to us from Baron de Watteville, whom, as you know, is interested in electric traction, and has done everything to ascertain the qualities or defects of the Victoria accumulator. The original letter is at your disposal if you desire to see it.

We also enclose the verbatim translation of the report of Mr. Johannet. They have read the article on the Victoria accumulator which appeared in your last week's issue, and Baron de Watteville was kind enough to send me one of the reports in support of what we have stated in our reply to "A Contributor."

The Eclipse Brass and Copper Company, Limited.
A. S.

Halifax, *May 18th*, 1899.

[COPY]

Paris, le 12 *Mai*, 1899.

The Eclipse Brass and Copper Company, Limited,
10, Harrison Road, Halifax.

Dear Sirs,—Enclosed I send you a copy of a most interesting letter from Mr. Johannet, consulting engineer for the Traction Company, and one of the most competent persons on traction in France. I attach *great* importance to his opinion, which will, no doubt, be highly appreciated by everybody.

(Signed) DE WATTEVILLE.

Compagnie Generale de Traction.
Capital, £20,000,000.

Paris, *March 20th*, 1899.

Baron R. de Watteville,
18, Rue Caumartin, Paris.

Dear Sir,—According to your desire, I now beg to give you the result of our trial at St. Denis with two cells of the Victoria accumulator (Mr. Schanschieff's), each weighing 14½ kilos. of total weight. We have tested them on the same conditions as we do with our cells in our practical working of them.

We have given a prolonged charge to the two cells joined in series, as we did not know the state of their charge at that moment.

On March 11th, 1899, we received a capacity of 183 ampere-hours at the average rate of 46 amperes, and the discharge has been stopped, as we usually do when the voltage dropped to 1·8 volts.

The E.M.F. on open circuit was 2·2 volts, and all the measurements were taken, while under the discharge, at the rate of 46 amperes.

We then re-charged the battery, giving them 200 ampere-hours, and put them on March 13th to a discharge at the same rate as the first. The voltage was always taken while the discharge lasted, and dropped from 2·2 to 1·78. We have received a capacity of 185·6 ampere-hours at the average rate of discharge of 46·4 amperes. The second discharge gave us an efficiency of 92·8 per cent. in quantity, and 75·2 in energy.

Under these conditions we can conclude that the cell is powerful, and taking into consideration its weight of 14½ kilos comprising the plates, liquid, box and connections. We received, at a rate of 3·2 amperes per kilo of the total weight, a capacity of 12·3 ampere-hours of the same weight, with an efficiency of 92·8 in quantity, and 75·2 in energy. These figures indicate sufficiently that these accumulators will take a prominent place for traction purposes, because of their large capacity and high efficiency, joined to their great lightness.

Electrical Energy Produced Directly from Carbon.

In the ELECTRICAL REVIEW for May 12th, Dr. Tommasi refers to a paper which I read recently at the Institution of Junior Engineers upon carbon-consuming batteries, and states that I incorrectly attributed a cell in which carbon is the soluble plate to Messrs. Case and Coehn. Dr. Tommasi appears to be under the impression that I claimed a certain priority for these investigators. That, however, is a mistake, I merely referred to their work, and I regret that I omitted to mention Dr. Tommasi. It is always rash to state that anybody was the first to carry out any particular investigation. I therefore trust I shall be excused; for even now I am only able to say that, as far as Dr. Tommasi is aware, he was the first to construct a carbon-lead-peroxide cell; I cannot say more, for claims of priority are seldom wanting if a matter is of importance.

In passing, it may be remarked that the cell due to Mr. Case is quite different to that described by Dr. Tommasi. That of the latter is not very aptly described as a battery *without metal*. It also appears rather strange, assuming carbon to be the soluble material, to have a carbon support for the depolariser. Such an arrangement is equivalent to supporting the copper oxide in a Lalande cell by means of a zinc plate.

As to the theory of the cell, it is a little difficult to follow the explanation given by Dr. Tommasi. What ground is there for believing that carbon acts as an ion? Everyone is aware that carbon is oxidised when it is used as an anode in aqueous solutions, for example, in dilute sulphuric acid, but that is no reason for supposing that carbon takes a position identical with that which is usually filled by the electro-positive plate of a cell. What is the electrolytic compound that is formed in which carbon is an ion?

When a current is generated, carbon may very possibly be oxidised, but this oxidation is not necessarily a source of electrical energy. It may be only a secondary reaction. Dr. Tommasi will reply that his view of the oxidation of carbon is borne out by thermo-chemical data. There appears, however, to be a mistake in the calculations. A volt is equivalent to 46,000 calories only if the element passing into solution is bivalent. Carbon is *tetravalent*, and consequently only half the calculated value must be taken, viz., 0·425 volt instead of 0·85 volt. This is very far from being supported by the observed E.M.F.

Nor is such a theory supported by facts. A carbon plate opposed to one of lead peroxide in dilute sulphuric acid gives an E.M.F. of about 0·9 volt. If this is due to the oxidation of the carbon it should be much altered by substituting platinum for the carbon. But such is not the case. Has Dr. Tommasi made any quantitative determinations of the oxides of carbon formed, and do they correspond with the current generated?

Dr. Tommasi states that lead peroxide exercises no chemical action on even a concentrated solution of chloride of sodium, from which fact we are presumably to conclude that chloride of sodium has nothing to do with the action of the cell described. Such a conclusion is, however, quite inadmissible. In voltaic action we are not concerned with the interaction of a compound (such as lead peroxide) and a solution as a whole, but with the compound and the *ions* of the solution. Consequently, such a statement as the above gives no information as to what may be expected voltaically. Obviously, if the lead peroxide were attacked by the sodium chloride it would be useless for voltaic purposes, as a kind of local action would be taking place.

There is no reason why the lead peroxide should not supply the electrical energy under certain conditions. Certainly without this body the carbon will give nothing, according to the suggested reaction, because the oxidation of carbon by water is endothermic. Dr. Tommasi appears to think that the chemical action must necessarily take place at the electro-positive plate, and that therefore the polarity will be reversed if the chemical action takes place at the lead peroxide plate. This is not so. The polarity of a plate must depend upon whether it interacts with the electro-positive or the electro-negative ion of the electrolyte.

W. R. Cooper, M.A., B.Sc.

Re Nernst's Lecture.

It is very cheering to learn from a gentleman of Mr. Rathenau's position and ability as an electrical expert, and being the director-general of the Berlin Company who purchased the European rights of the above, he should of a certainty know what he was talking about. That "Nernst's lamp will neither supersede the glow lamp or arc lamp, but will serve as a welcome addition to both." These are his exact words according to your report. So that Mr. Jas. Swinburne *is wrong again*; for if you remember, sir, he when lecturing upon Nernst's lamp, on February 8th last, distinctly declared that "once the Nernst lamp becomes so general that systems of distribution are laid out to suit it,

instead of to suit the carbon lamp, the carbon lamp is practically out of the running."

Is it not foolish, sir, to prophecy unless one knows?

The above extracts prove which of the above experts are to be relied upon. And poor glow lamp makers may take heart of grace, seeing that, according to Mr. Rathenau, carbon lamps *will not be superseded* by the "naked flame," and so are likely to be "ever" in the running for the "commercial and public service stakes," despite Mr. Swinburne's premature declaration uttered but a month previous to the "questionable" flotation of Nernst's lamp.

Hoping you will oblige a regular reader, I thank you in anticipation for insertion.

Observer.

Re Telephone Cables.

In our letter appearing in your issue of April 14th, we made the assertion that "no paper cable having 612 wires, 20 gauge, and an outside diameter $2\frac{3}{4}$ inches has given an average capacity of 0·080 mfd. per mile." The contrary had been supported by "E. J. J." He says: "0 080 mfd. should be the capacity of all the wires in any cable." Among these is named 612 and 500 wire cables, the conductors of which are said to be 20 S.W.G., and to have 42 3 ohms resistance in $2\frac{3}{4}$ inches of tube.

Answering us, "E. J. J." admits that he only meant ·080 mfd. to apply to cables of 408 wire, but he adds the valuable fact, "The capacity of the large (*i.e.*, 612 wire 20 gauge) cables, is not above 0·087 mfd. per mile." He says "These are the results of a number of tests of cables which have been laid in the ground.

Perhaps "E. J. J." will pardon us for supposing that he has made a further slip by confusing cables made of 20 gauge 42·5 ohms per mile with cables made of 22 gauge 73 ohms per mile, the latter obtain easily of course the capacity he claims with an outside diameter of 2·55 inches.

If "E. J. J." would kindly name any of the *numerous places* where he says such cables are to be seen or their tests verified, we, and other readers, would be greatly obliged.

O'Gorman & Cozens-Hardy.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week ending May 24th, 1898.		Week ending May 23rd, 1899.	
Amsterdam	Value £83	Alexandria. Teleg. mat.	Value £412
Antwerp	188	Amsterdam	165
„ Elec. fuses	283	Antwerp. Teleg. mat.	152
Beira	256	Bombay	128
Bombay	45	Borneo	54
Boulogne	89	„ Teleg. mat.	205
Calcutta	379	Boston	35
Cape Town	623	Boulogne	13
Copenhagen	12	Brisbane. Submarine cable	1,219
Delagoa Bay	57	Buenos Ayres	2,186
Durban	51	„ Teleg. mat.	174
East London	149	Calcutta	948
Flushing	15	Cape Town	28
Fremantle	215	Colombo	299
Gibraltar	75	Durban	401
Gothenburg	47	East London	87
Halifax	820	Flushing	18
Hamburg	195	Gothenburg	66
Hong Kong	58	Hamburg. Teleg. mat.	150
Madras	208	Hong Kong	15
Melbourne	32	Madras	271
Natal	1,360	Melbourne	205
North Atlantic. Teleg. cable	10,800	Odessa	25
Port Elizabeth	1,403	Ostend	10
Rotterdam	42	Port Chalmers	1,440
St. Petersburg. Elec. launch	420	Port Elizabeth	216
Singapore	170	Rotterdam	37
Stockholm	232	Shanghai	101
Sydney	610	Singapore	71
Trieste	240	„ Teleg. mat.	68
Wellington	49	St. Petersburg	71
Yokohama	160	Stockholm	300
		Sydney	740
		„ Teleg. mat.	140
		Tientsin	650
		„ Teleg. mat.	200
		Trinidad. Teleg. mat.	85
		Vigo	800
		Vladivostock	180
		„ Teleg. mat.	42
		Yokohama	356
Total	£19,266	Total	£12,708

Foreign Goods Transhipped.

Durban	Value £19	Durban	Value £33
		Philadelphia	28
		Trinidad. Teleg. mat.	93
		Total	£154

Alleged Theft.—At Marlborough Street on Tuesday, James M'Carthy, 37, a porter, of High Holborn, was charged on remand, before Mr. De Rutzen, with being in the unlawful possession of 37 electrical cut-outs, and with being concerned with Frederick Abrahams, 32, a seaman, of Colville Place, in stealing electrical fittings, worth £5, from the Queen's Hotel, Leicester Square; Henry Fisher, 42, electrical engineer, of 16 and 16a, Dean Street, Soho, was charged with feloniously receiving a large quantity of electrical fittings.—Mr. Williamson, who prosecuted on behalf of the Treasury, said that property of the value of about £560 found at Fisher's premises had been identified as stolen from various parts of London. After evidence had been given, Mr. De Rutzen remanded the accused for a week.

Bankruptcy Proceedings.—At the Bankruptcy Court on the application of Messrs. Cortellis & Co., on behalf of the petitioning creditor, a receiving order was made against E. L. Joseph, described as of the Northampton Works, Northampton Grove, Canonbury, electrical engineer. The act of bankruptcy alleged is non-compliance with the requirements of a bankruptcy notice.

Last Saturday, before Mr. Registrar Hood, at the London Bankruptcy Court, on the application of Messrs. Tatham & Co., on behalf of the petitioning creditor, a receiving order was made against W. J. Carruthers Wain, of Eldon Street, Finsbury, late of the Edinburgh Hotel, St. Leonards-on-Sea, director of public companies. The act of bankruptcy alleged is non-compliance with the requirements of a bankruptcy notice.

The last day for recovering proofs in *re* W. A. Charles and J. S. Blackwell (Central Electrical and Engineering Company, Leicester) is fixed as June 9th. Trustee, W. M. Richards, 52, Belvoir Street, Leicester.

We understand that a receiving order has been made in the Coventry Bankruptcy Court in respect to the estate of Henry James Wimshurst, electrical and motor car engineer, 4, Foleshill Terrace, Foleshill Road, lately residing at the Greylands, Foleshill Road, Foleshill.

Bastian Electricity Meters.—The Bastian Meter Company, Limited (formerly the Penny-in-the-Slot Electric Supply Syndicate) is circularising the shareholders, giving an outline of the company's operations up to April, 1899. After its formation in July, 1897, the company devoted its first 12 months to experimental work, which resulted in the invention of the ordinary type of meter, as distinguished from the prepayment type. They have been manufacturing this meter (known as the Bastian meter) since September, 1898, and have now sold over 900 to the following companies and corporations: Corporations—Glasgow, Bradford, Llandudno, Stockport, Brighouse, Dundee, Oldham, Dewsbury, Manchester, Nottingham; Windsor Electrical Company, Bourne End Electrical Company, Christie Brothers, Chelmsford; Calvert & Co., Manchester; Barking Town Council; Madeira Electrical Company; Mardy, South Wales. Sample meters are now under test in Birmingham, Edinburgh, and many other towns, at home and abroad. It is estimated that an output of 5,000 meters per annum should show a sufficient profit to provide for a dividend of 5 per cent. on the ordinary share capital, after providing the interest on the preference shares, and a possible output of 15,000 to 20,000 meters per annum is not thought to be an extravagant estimate. The company has purchased the undertaking known as the Electric Lighting Extension Syndicate, Limited, and so extinguished the royalty of 4s. per meter, which was payable to them under their original agreement as vendors to this company.

Book Received.—"Telephones: Their Construction and Fitting," by F. C. Allsop. London: E. & F. N. Spon, Limited, 125, Strand. 3s. 6d.

Brazil.—A London financial contemporary says that the Brazilianische Electriztäts-Gesellschaft has been authorised to operate in Brazil. The capital is 5,000,000 marks in 1,000 marks shares. The object of the company appears to be to acquire and operate electric tram, lighting, and telephone systems.

Changes of Address.—Messrs. Walter Dixon & Co. have removed from 164, St. Vincent Street, to 59, Bath Street, Glasgow.

Compressed Air.—The Pneumatic Supply and Equipment Company, a new organisation, has opened an office at 120, Liberty Street, New York. It is the purpose of this company to deal generally in compressed air equipment, and it will make a specialty of the installation of complete plants, eliminating division of responsibility. Mr. J. W. Duntley is the president; Mr. E. B. Gallaher, vice-president and engineer; and Mr. W. P. Pressinger, formerly manager of the Clayton Air Compressor Works, is secretary and treasurer.

Dining Table Lighting.—Messrs. Drake & Gorham announce reductions in the prices of their patent dining table connector, owing to the largeness of the demand therefor.

Electric Launches.—The Morecambe Electric Launch and Power Syndicate, Limited, have now nearly completed their arrangements for commencing operations. The company have on order a first consignment of two launches now nearly ready. The boats have been built by the Vril Launches, Limited, and are after the pattern and model of those recently supplied to the Czar of Russia and the P. and O. Steamship Company.

Electricity for the New Royal Yacht.—The New Royal Yacht *Victoria and Albert*, recently launched at Pembroke Dock will, it is announced, be lighted by electricity throughout,

generated by three dynamos—one fitted in each engine room, and one in the passageway or recess between the after boiler and the engine rooms—each of which will be sufficiently powerful to light the entire ship, which, outside the Royal apartments, will be fitted with about 550 incandescent lamps. An official description of the ship recently issued said that "the electrical installation will be of a special character. It will provide not only for the electric lighting of the interior, but for other applications of electrical power, including lifts, pumps, hoists for boats, ventilating fans, and heating the principal apartments. By using electricity instead of steam for these auxiliary services it is anticipated that comfort and efficiency will be increased." In addition to the electric installation the ship will be provided with a complete outfit of Colomb's lamps. The State apartments will be heated by electricity, and steam heating will be adopted elsewhere. In addition, ventilation fans driven by silent electric motors will be fitted on board. The electric fittings, which are to be of the most elegant character, are to be put on board by private contract. The electrical arrangements of other portions of the ship will be fitted by dockyard workmen.

Ericsson's Telephones.—Messrs. L. M. Ericsson & Co., Limited, intimate, that in consequence of the greatly increased demand for their telephone instruments and accessories they have deemed it right in the interests of their customers to open a branch in England. The offices and showrooms of the company are at 154-5, Temple Chambers, Temple Avenue, E.C.

In Re Poole & White.—Mr. E. Wilding, who was appointed liquidator in the matter of Poole & White, in January, 1893, is applying to the Board of Trade for his release, and has now issued a summary of his receipts and payments as liquidator. This shows receipts of £700 surplus from securities, and £10 equity in lease = £710, which sum has been expended in law fees, liquidator's and other charges. (The Company's statement was that the receipts were estimated to produce £23,580.) The receiver for the debenture holders carried on the business until the middle of 1896, when the remaining assets were disposed of realising £5,600, but this was only sufficient to pay the holders of the first issue of debentures 16s. in the £, and left the second issue totally unprovided for, and the third issue also unprovided for, excepting as to the result of their claim on the uncalled capital. This matter was arranged between Mr. Wilding and the third issue holders, he receiving £700 of the unpaid calls as mentioned above.

The "Little Giant" Electrical Turbine.—The advantages presented by the mounting of turbines on horizontal shafts are perfectly obvious. Many kinds of machinery can be driven by direct coupling to a horizontal turbine shaft, such as electric dynamos; or, again, if a belt be desirable, the power can be transmitted either to a single machine or to a lay shaft at a minimum waste as compared with the force consumed by gearing. That in itself is often a factor of no little moment, to say nothing of the first cost and maintenance charges incident to gearing—no inconsiderable items. Another advantage obtained by the horizontal setting of a turbine is this, that such a wheel will be above the tail water level; hence all parts are easily accessible, and the full head of water can be obtainable by means of draft tubes. An instance for which these advantages are claimed is the "Little Giant" turbine, which is well known to the milling trade. Mr. S. Howes, of Mark Lane, E.C., has for the past 15 years, made a careful study of the horizontal setting of this water motor, and the illustration shows the latest style of the horizontal "Little Giant," which is the outcome of years of untiring observation and costly experiment. It is claimed on behalf of this turbine that its construction and design peculiarly favour a horizontal setting, inasmuch as the buckets are so formed, and the discharge is such that this wheel can be used in connection with draft tubes, and so obtain the highest attainable percentage of power from the water and fall. The makers of this motor are careful to claim that a glaring defect of turbines of this class, to wit, either lateral or end thrust, is absent in the "Little Giant," thanks to the perfect balance attained by its peculiar design. This turbine is a double wheel, that is to say, it consists of two sets of buckets, keyed on one shaft, and these buckets are so formed that whatever end thrust there may be from one set, is counteracted or balanced by that of the other set. This balance is a point of capital importance, and is not to be attained in all types of turbine. The construction of this water motor, and of all its appurtenances, is solid and simple. The wheel is covered up by its casing, which is cast in two parts, and securely bolted together on a line with the wheel shaft; thus the casing is made watertight, and of great strength. To give ready access to the buckets, hand-holes of convenient size are provided in the casing. A strong point is the ready accessibility of the whole mechanism; thus, to lay the whole wheel bare (as in the figure) in a few minutes, it is only necessary to remove the bolts in the flange, when the casing can be readily removed without any disturbance to either the wheel or shaft bearings, or the stuffing boxes. This is claimed as a valuable feature, because in case of any obstruction of the wheel due to anything getting into the buckets, the whole cause of the trouble can be removed at a minimum expenditure of time and trouble. To ensure perfect rigidity, a vital point with a horizontal turbine, the casing, and the wheel and shaft bearings, are bolted to a strong cast-iron bedplate; hence it is almost impossible for the shaft and buckets to get out of alignment. There being but one gate, which is watertight, there should be no loss of water. Mr. S. Howes will have an exhibit of these turbines, both vertical and horizontal patterns, Champion water motors, at the Bath and West and Southern Counties Show, being held at Exeter until May 29th, stand 168, shed 46.

Mr. Howes will also have an exhibit of his turbines, Champion water motors, &c., at the Royal Agricultural Society's show, to be held at Maidstone from June 17th to 23rd.

Liquidations, Dissolutions, &c.—Notice appears in the *London Gazette* to the effect that a petition for the winding up of Messrs. Williamson & Joseph, Limited, presented on 8th inst, by H. Sherley-Price, W. R. Goulty, S. Sherley-Price, and E. Sherley-Price (Wheatley Kirk, Price & Goulty) creditors, will be heard by Mr. Justice Wright on May 31st.

Messrs. J. Moores & H. O. Farrell (Moores, Farrell & Co., electrical engineers, 26, Victoria Street, S.W.), have dissolved partnership. Mr. Moores will attend to debts.

Lists.—The Mercier's Patents, Limited, of Manchester, are sending out various illustrated price lists of their patent mining bells, watertight treadle or automatic contact box, junction, fuse, and test boxes, &c.

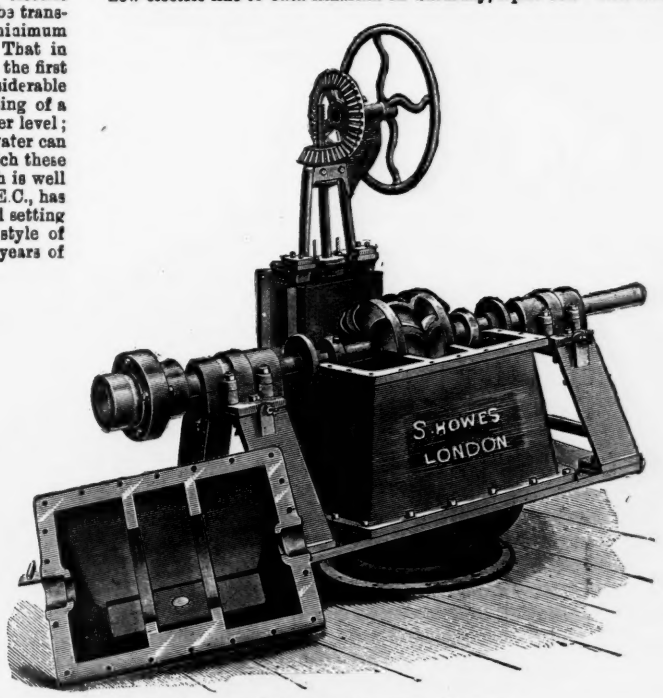
Messrs. Ernest Scott & Mountain send us a neat illustrated pocket folding card of their compound double-acting self-lubricating side-by-side enclosed engines, and also tandem three-crank compound engines. The list gives the effective powers and electrical outputs at varying speeds and steam pressures.

Mr. Wm. Patterson, of Walker Gate, sends us a revised list of his copper wire gauze dynamo brushes.

Messrs. Shelby & Co., of Finsbury Circus Buildings, E.C., send us an illustrated list of the "Warden" oil filter and purifier, which is claimed to be very effective and economical; also Brown's friction clutches.

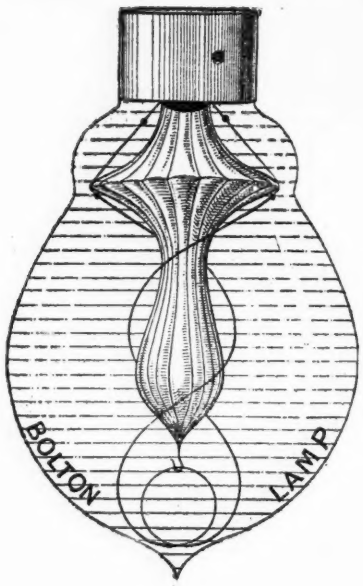
The Nernst Lamp in Germany.—The German patent authorities have inquired into the objections raised against a patent being issued in respect of the Nernst lamp, but have decided that there is no ground for not granting it. The patent has accordingly been issued.

River Plate Notes.—The *Review of the River Plate* says that the public lighting of the City of Buenos Ayres during February was done by means of 83 2,000-N.C.P. arc lamps, 203 of 1,000 N.C.P. and 100 of 16 C.P., 13,601 gas lamps, and 7,631 kerosene lamps. The total cost of the lighting being: electric $8,327.62, gas $31,606, kerosene $19,077.—The Intendente of Buenos Ayres has contracted with the Cía. Transatlántica Alemana for 150 10-ampere arc lamps at the rate of $17 40 $^{m}/_{n}$ per month, to be alight from sunset to sunrise.—The La Capital Tramway Company open their new electric line to Casa Amarilla on Saturday, April 1st. Cars will run in combination with the train service, and the journey will be done in 8 minutes, as against 20 to 25 at the present time. Cars will run every six minutes from the Plaza de Mayo.—A very valuable copper mine has been discovered in the Departn ent of Maipo, near Santiago de Chile. The mineral gives 65 per cent. pure copper. The copper mines that have lately been discovered in the Province of Pasco in Peru are giving excellent results, the ore being of first-rate quality, and there is plenty of it. Seeing the spurt that has lately taken place in the copper market, the Chilian and Peruvian mines should return to their former prosperity.—A large carbide of calcium factory is to be established in Córdoba, the electric power being supplied by the Córdoba Electric Light and Power Company.



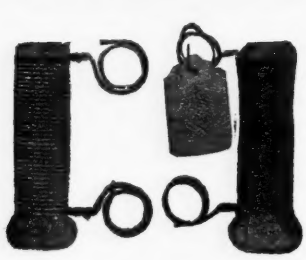
THE "LITTLE GIANT" ELECTRICAL TURBINE.

The Bolton Lamp.—The illustration shows this new incandescent lamp, which is the invention of Mr. John J. Bolton, of West Hampstead. The main novelty is found in the reflector which is composed by preference of clear glass, silvered inside, and white



opal, and is fixed in position by being fused with the glass forming the outer bulb, when the bulb or lamp is being closed. Hooks can be attached to the reflector for the purpose of supporting the filament. We are informed that when the lamps burn out the reflectors may be taken out for re-insertion in new bulbs by the makers.

Standard Resistance Units.—The Ward Leonard Electric Company have recently put upon the market a complete line of standard resistance units for all branches of the electrical business. A typical resistance unit is shown in the accompanying cut. As will be seen, a wire is first wound upon the surface of a tube and substantial terminal leads are placed upon the tube to hold the resistance wire in position. The tube itself is a special pottery tube. At the left is shown the pottery tube with its resistance wire in position. The entire tube is then given a coat of enamel, which holds the resistance wire in position, and protects it against mechanical, chemical and electrical injury. At the right is shown the completed resistance unit. These units are made in three capacities, viz., 36 watts, 72 watts, and 125 watts for continuous duty, designated as A, B and C size respectively. Each size is kept in stock by the Ward Leonard Company in 26 different standard windings, the ohms varying from 1,000 ohms to ·15 of an ohm by an evenly



graded series, and the ampere capacity varying correspondingly from ¼ of an ampere to 30 amperes. The units can be readily mounted upon the back of a slate by means of small bolts passing through the centre of the tubes. It is said to be impossible to have a ground in using them, as the tube is entirely composed of the most perfect insulating material. The makers state that they are meeting with a very strong demand for these resistance units, and are turning them out at the rate of many thousands per week. By the use of the resistance units, and guided by the comprehensive tables of the Ward Leonard Company giving the ohms, amperes, volts and watts of each unit, it is possible to construct any desired rheostat, with any desired number of steps, any desired watt capacity, and any desired taper in ohms or in amperes, which will often be of the greatest service to the electrical trade.

The Telephone Muddle in London and New York.—London is not alone in the sufferings it is reputed to bear from an expensive and inefficient telephone monopoly. New York, it appears, is afflicted in a somewhat similar manner. We are so accustomed in this country to have trans-Atlantic methods in things electrical held up to us as patterns, which we may hope to copy, but never to improve, that a paragraph like the following comes rather as a shock:—"It is safe to say that the telephone situation in New York City has never been in a more chaotic condition than it is at the present time. In Albany the friends and supporters of the New York Telephone Company are apparently making every effort to prevent the passage of any Bill which would reduce telephone charges and thus prevent the existing company from declaring at the public's expense its usual large dividends on an inflated capitalisation, while in New York City every possible obstacle is being placed in the path of the People's Telephone Company with a view to preventing that corporation from running wires and opening exchanges."—*Electricity* (New York). In London the complaints have been generally against the existing monopoly and based chiefly on bad service, in New York the exorbitant charges appear to have been the chief element of the subscribers' dissatisfaction. In both cases the companies having the monopoly are fighting against the proposed reforms, and are expending money and energy in this way, which if spent upon removing the causes of dissatisfaction, would vastly improve their position with the general public. At Albany the Bill introduced into the State Legislature by those who desire that the reform should be in the shape of legislative registration of the tariff charges, is met by the arguments that the threatened independent competition will render this legislative action unnecessary. But independent competition, when once established, must be permanent to effect permanent reform; and, as the following paragraph from the *New York Herald* shows, the monopolists have an objectionable habit of rendering such competition exceedingly transitory in character:—"In several Western cities telephone companies independent of the Bell have been organised, and have knocked the business of the Bell monopoly all to pieces. It has made the stock of the Western Central Telephone Company, an auxiliary of the Bell, almost worthless. Recently the Bell monopoly started out to buy these companies. It claims to have bought some. Others refuse to sell; but the mere fact that the Bell was after these companies was sufficient to send the stock of the American Bell in Boston from $275 to $313 a share. The fact that the Bell monopoly intends to fight opposition by buying it out and continue extortion so long as possible in order to pay 18 per cent. dividends has greatly lessened the argument that competition regulates the price of telephones." The chief argument used by opponents of the State regulation of tariff charges is therefore fallacious, but it may prove efficacious at Albany in defeating the Bill alluded to above. In New York the opposition to reform is making its appearance in the Municipal Assembly, in one branch of which it was recently proposed that a $10 annual tax on poles and a still more onerous tax on conduits, should be imposed *in future* on all poles erected, or conduits laid, within the city bounds. This proposal, if carried, would simply handicap any newly-formed telephone company, and it is supposed to have been aimed at the People's Telephone Company, the most vigorous and dangerous of the rivals of the New York Telephone Company. That the People's Telephone Company is deserving of public support is proved by the fact that it is about to promote a Bill making it a misdemeanour for competing lines to consolidate. But the promotion of such a Bill is by no means the same thing as carrying it, and we should be surprised to hear that it had passed the New York State Legislature, all of which only proves that unregulated monopolies in large cities are generally *bad* in principle, are certainly *bad* in practical operation, and when once established, are excessively *bad to kill*.

Trade Announcements.—The Chicago Pneumatic Tool Company has purchased the patents formerly owned by the Consolidated Pneumatic Tool Company, now defunct. These patents include all the Keller and Wolstencroft types of tool construction, and in addition several new applications which have not yet been taken out.

Mr. F. J. Pether, electrician, has taken premises at 16, Hall Street, City Road, E.C.

Mr. W. E. Burnand, late of Club Garden Walk, Highfield, has removed to larger and more convenient premises at Ocean Works, 119, St. Mary's Road, Sheffield, where the business will now be carried on under the name of W. E. Burnand & Co., electrical engineers. The new premises are well stocked with modern machinery.

ELECTRIC LIGHTING NOTES.

Alva.—Several communications have lately been received by the Burgh Commissioners from companies anxious to supply the town with electric light, but the Commissioners will leave the matter in abeyance at present in view of the scheme now on foot to lay a light electric railway between Stirling and Tillicoultry.

Bexhill.—The Council has decided to defer for six weeks the proposed building of an electric light station in view of the offer of the British Electric Traction Company to take over the electric lighting for the town.

Bridgwater.—The Council has adopted a recommendation of the Lighting Committee that an electric lighting scheme for the whole of the borough be proceeded with on the low tension system, in accordance with a decision arrived at in 1897.

Brighton.—The Corporation will, after June 30th, with the Board of Trade's consent, increase the standard pressure from 115 to 230 volts in the streets described in the schedule just advertised in the local press.

Bristol.—A Local Government Board inquiry was held last week *re* the proposed loan of £41,650 for electric lighting extensions. Mr. Faraday Proctor explained the scheme, with its mains, extensions, transformer, sub-stations, &c. The Council will purchase the leasehold interests of three properties contiguous to the central station, to be prepared for possible contingencies. The new plant for the station will include two Babcock & Wilcox boilers, &c.

Buxton.—The District Council is to raise a loan of £24,769 for electric lighting purposes at 2½ per cent.

Camberwell.—The General Purposes Committee has engaged Major Cardew to advise the Vestry fully on the works already carried out by the County of London and Brush Company.

Cambridge.—The Town Council last week resolved, subject to the Board of Trade's approval, to serve notice upon the Cambridge Street Tramways Company requiring them to sell their undertaking.

Canterbury.—It is stated that the working of the electricity undertaking for the first five weeks (ended March 31st) shows as follows:—Revenue account from February 23rd to March 31st—Receipts from sale of current and public lighting, £131 3s.; meter rents, £4 1s. 3d.; sundry fees, £1 2s.; total, £136 6s. 3d. On the expenditure side is debited the charge for telephonic communication for an entire year, also rates, insurances, &c., totalling £27 9s. 4d. If these charges were apportioned for the five weeks only, there would be a profit on the revenue account of about £11; but as the account stands, there is a balance against of £13 17s.

Cardiff.—Last week the Electric Lighting Committee adopted a report by the electrical engineer, in which he stated that he had made inquiries as to how many customers were likely to take the current if the wires were extended to King's Road, Romilly Crescent, and Sneyd Street. Including Mr. Sydney Walker, who made the application, and who wanted the current for power purposes during the day, there were six promises already. The cost of extending the wire would be £443, and the probable revenue would be £84. The loan charges would be £28, so that there would be a substantial balance. The Committee decided to recommend the Council to make the extension. Upon Mr. Applebee's suggestion, it was decided to recommend that customers using the current for power in the daytime should be charged at 2½d. per unit if they used under 4,000 units, and 2d. a unit if they used over 4,000 units per annum.

Coatbridge.—A member has given notice of motion that a committee be appointed to negotiate with the Scottish House-to-House Electricity Company, Limited, as to the terms upon which they would be prepared to sell their undertaking.

Corpach.—Mr. Stirling, of the Fort William Electric Light Company, has been canvassing the householders in and around Corpach, with reference to bringing the electric light to the village.

Coventry.—Satisfactory progress is being made with the extensions to the electricity works. The new buildings will be completed in about a couple of months. The new sub-stations are finished, and the arc lamp standards in position.

Dublin.—The Local Government Board has sanctioned the application of the Corporation for loans for electric lighting purposes, amounting to £24,000.

Dudley.—The Board of Trade has granted the Midland Electrical Corporation for Power Distribution, Limited, a provisional order to supply electricity for public and private purposes within an area around Dudley, but has excluded Dudley from the area to be supplied.

Douglas (I.O.M.).—A Liverpool paper says that Douglas ratepayers are criticising the Council's action in not reading the offer of the Isle of Man Tramways Company at the meeting when the electric lighting question came under consideration. It is stated that in the adopted scheme the cost of supplying current is put down at a minimum of 5d. per unit, allowing for interest on sinking fund. The offer of the Tramways Company, which was not read, was 2¾d. per unit for the first 200,000 units, 2½d. per unit for the third 100,000 units, and 2¼d. per unit for 300,000 units and all in excess.

Ealing.—Several small main extensions were decided upon by the Council last week. The engineer is to prepare an estimate for renewing the pilot voltmeter wires.

Enfield.—The English Industrials, Limited, has asked the Council whether it may take over a provisional order for electric lighting if the Council obtains it. The Council will consider the matter in committee.

Gillingham.—The Urban District Council has resolved that the whole of the offices be fitted with electric light in place of gas.

Glasgow.—The Watching and Lighting Committee has received a report by the officials on the subject of lighting stairs by electricity. The matter has been submitted to a sub-committee to confer with the sub-committee of the electricity department and to report. The officials state that common stairs, where the service mains are laid into the building from the street mains for the purpose of supplying private consumers within the building, could be lighted by electricity at the rate of 25s. for a 6-candle-power lamp, 27s. 6d. for 8-candle-power, and 37s. 6d. for 16-candle-power, subject to the following conditions:—(1) That the owner provide the fittings at his own cost; (2) that while the Corporation should renew the incandescent lamps when required, owing to ordinary wear and tear, the electricity department shall not be called upon to make good wilful damage or destruction; (3) that the lamps be lighted, extinguished, and reported upon by the police department.

Greenock.—On 16th inst. the Electricity Committee reported that letters had been submitted from the General Post Office, London, with regard to the laying of mains for electric lighting and the proposal to provide tubes alongside the same for the use of the National Telephone Company. The Post Office had no objection to the Corporation executing the proposed works so far as the electric mains are concerned under the usual notices to the Post Office Telegraphs Department, but pointing out that under Clause 6 of the Telegraph Act of 1892 any agreement with the Telephone Company must be authorised by the Postmaster-General. The letters were submitted to a sub-committee.

Hastings.—Last week the Council adopted a report of the Public Lighting Committee regarding an application for current to be supplied to certain premises in Grosvenor Crescent, West Marina. The engineer estimated the cost of the various mains and laying same, also the necessary sub-stations, would cost £1,750. He did not advise the expenditure of this sum all at once, but when the probable revenue from the thoroughfares interested would justify it. The Council is applying to the Local Government Board for sanction to the necessary loan.

Heywood.—The Corporation, being about to establish electric supply works, is advertising for the services of a consulting electric engineer. Particulars from the borough engineer, Heywood, or from the town clerk.

Hornsey.—Several inhabitants of Highgate have petitioned the District Council asking to be supplied with electric light.

Huddersfield.—The borough electrical engineer's report which has been adopted by the Council shows that in May the consumers numbered 867, lamps connected 56 516, and units metered 48,251, as against 858 consumers, and 55,990 lamps connected in April, and 36,247 units metered at the corresponding period last year. It has been decided to reduce the cost of electrical energy from 6d. to 4½d. per unit, subject to a sliding scale of discounts, such reduced charges to take effect from July 1st, 1899, in addition to 5 per cent. discount for cash. Extensions to Lockwood and Blackhouse Bridge Road have been decided upon.

Islington.—The Electric Lighting Committee of the Vestry recommends extensions of the electric lighting mains to the Hornsey Rise and Newington Green districts at a total cost of £60,000, and extensions to the Highbury district at a cost of £7,150.

Kingswood.—The Council is proceeding with its gas lighting scheme, and has settled the squabble between itself and the Western Counties Electric Light and Power Syndicate by paying £30 to clear itself of all claims for lighting, &c.

Leeds.—Last week the Council agreed that application should be made to the Local Government Board for sanction to borrow the sum of £150,000 for electric lighting purposes.

Limerick.—Last week, at a special meeting of the Corporation, a proposal from the Dublin Districts and Provincial Electricity Corporation to buy the Gas Works and light the city by means of electricity was considered. A committee recommended its rejection. Mr. Sax, who represented the syndicate, attended. The report rejecting the proposals was unanimously adopted, and the matter will not be further considered.

London.—The City of London Electric Lighting Company is advertising its intention to apply to the Corporation for its approval to alter the standard pressure of private supply from 100 to 200 volts.

The *City Press* says that the Streets Committee and the City of London Electric Lighting Company have discussed the points at issue on the subject of the future of civic electricity. Our contemporary understands that there is little likelihood of an amicable agreement being come to between the parties, and that probably Sir Courtenay Boyle will have to settle the matter by himself. The question of the contracts with the company were to come before yesterday's meeting of the Court of Common Council.

Merionethshire.—At the Towyn and Aberdovey Urban District Council meeting in the course of discussion on the electric light question during which it was remarked that Colonel Ruck, who had propounded the electric lighting scheme, had gone abroad for two years, it was stated by Mr. D. C. Davies that "another scheme for providing electricity had been invented." It was about to be tried at Plas Machynlleth. "The latest scheme would be worked by means of acids. No motive power would be required, and it was much less expensive." He suggested that the matter should be deferred for the present. The suggestion was adopted.

Oldham.—The Surveyor's and Sanitary Committees met the chairman of the Electric Light Committee last week to confer upon the question of land required for extending the electricity station at Rhodes Bank.

Ross.—The District Council last week decided to engage Mr. Kilgour, of the Cheltenham electricity works, to prepare plans and specifications for electricity works, with an approximate estimate of the cost.

Russia.—The several central stations of the Société d'Eclairage Electrique de Saint Petersbourg are now supplying current to an equivalent of no less than 46,700 16-C.P. lamps.

St. Anne's.—The Urban District Council have under consideration the question of establishing an electric lighting system for the town. It is proposed to construct the works in St. Andrew's Road North, and the system thought of is the three-wire low tension direct current, with a pressure of 400 volts across the outer wires and 200 volts from the main to the consumer. Mains are to be laid to all streets where there are street lamps, and electricity used largely for street lighting. The Brighton system of charging is suggested, the consumer being charged 7d. per unit for the first hour, and 4d. per unit for subsequent hours. Mr. Tiddeman, the electrical engineer to the Council, estimates that the current can be produced at 2·1d. per unit. The total cost is put down at £23,000, of which £18,000 will be required now and £5,000 for extensions required during the next five years. Buildings are to cost £1,800, boilers, &c., £1,030, engines and dynamos £2,500, battery, £1,100, mains £5,000, arc lamps £500, incandescents £1,000, and meters £1,600.

Salford.—On 19th inst. a Local Government Board inquiry was held *re* the proposed loan for electric lighting extensions. It was stated that it is proposed to build an electricity generating station in Strawberry Hill Road, Pendleton, at a cost of £5,822. Councillor A. Haworth, chairman of the Electric Lighting Committee, said applications had been received for twice the amount of power they could at present produce. The first generating station was built three years ago, and the loss on the undertaking in the first year was £3,975, including the sinking fund. In the following year the amount was £2,900, and in the third year, up to last March, £855. The inspector said there was every appearance of a probable profit when the new station was provided.

Shildon.—The Urban Council has authorised a committee to communicate with an electric lighting company for obtaining information regarding the terms for which the district could be lighted.

Stafford.—Alderman Wright, in presenting the annual statement of the gas department for the year ended March 31st last, after dealing with the gas lighting accounts, added that the accounts of the electricity department had not yet been completed, but they should not want to make a call upon the rates. They would most likely be able to pay the whole of their working expenses and interest upon borrowed capital, but not the payment to the sinking fund in reduction of capital, which would be taken from the balance standing to the credit of the electricity department. The electric energy generated at the works for the year was 91,134 Board of Trade units, being an increase of over 15 per cent. more than last year, and the number of 8-C.P.—or their equivalent—lamps connected was 7,346, being an increase of 1,146. The Committee had under consideration large additions to the electricity department, and hoped in the course of a few years it would be as profitable an undertaking as the gasworks, and so far they were quite satisfied with the progress made.

Stockport.—The Omnibus Bill of the Stockport Corporation was considered before the Police and Sanitary Committee of the House of Commons, under the chairmanship of Sir Stafford Northcote, on Wednesday and Thursday last week. The Bill contained clauses dealing with the purchase and working of tramways, and the supply of electricity in the neighbourhood of Stockport. Mr. Pember, Q.C., Mr. Pembroke Stephen, Q.C., Mr. Balfour Browne, Q.C., and Mr. H. E. Lloyd represented the promoters of the Bill. It was announced that the opposition of the Urban District Council of Heaton Norris had been withdrawn, owing to the deletion of the clause in the Bill giving compulsory running powers in the district of Heaton Norris.—Mr. Pember explained the Bill, and said that with regard to the electric lighting, it was proposed to take power to supply the adjoining district with electric light and fittings. Stockport was the centre of a very great district, which they had already supplied with gas and water, and it was desirable that the supply of electricity should be in the hands of one authority. The powers were not compulsory, but could only be exercised with the consent of the local authority of the district concerned.—Mr. T. Webb (Mayor of Stockport) gave evidence in support of the Bill, and expressed the opinion that the Corporation could as a manufacturer on a large scale of electricity be able to supply it cheaper than the smaller districts could generate it for themselves. The preamble of the Bill having been passed, the Committee proceeded to deal with the clauses, and decided that words must be inserted to meet the objection of the Local Government Board in regard to the form of accounts of the electric lighting and traction undertakings, so that the traction account should be kept separate. Protective clauses were inserted to meet the wishes of the Cheshire County Council and the London and North-Western Railway Company. On Thursday new clauses dealing with the apportioning of the expenses of the tramways and the electric lighting between the Committees controlling these matters, were brought up and accepted by the Committee.

Tewkesbury.—A member has given notice to the Council of his intention to move that a provisional order be applied for.

Tonbridge.—Mr. R. Hammond lectured on 16th inst. at a meeting of the Ratepayer's Association on electric lighting. He said that a scheme for Tonbridge would cost, roughly, £17,000.

Tunbridge Wells.—The Tradesmen's Association last week had a discussion regarding the high charges for electric current, and it was decided to petition the Lighting Committee, asking for reductions. There was a discussion on the question of free wiring, objections being raised to a London Free Wiring Company competing with the local tradesmen. It was stated that the Corporation was to be memorialised by the ironmongers of the town against the system.

Ventnor (I.O.W.).—Some ratepayers have petitioned the Council in favour of the extension of the street arc lighting by the acceptance of the offer of the Ventnor Electric Light Company in that connection.

Ystradyfodwg (Mardy).—A Select Committee of the House of Commons, presided over by Sir Henry Fletcher on Wednesday and Thursday last week, considered the Bill for the confirmation of an electric lighting provisional order relating to Ystradyfodwg. Mr. Claude Baggallay, Q.C., and Mr. Rhys Williams appeared for the promoters, and Mr. Balfour Browne, Q.C., and Mr. Ram represented the Ferndale Gas, Light and Coke and Waterworks Company, who petitioned against the Bill on the ground that if the order was confirmed it would damage their interests, inasmuch as they would be deprived of the public lighting of Mardy. After hearing evidence for and against the Committee consulted in private and afterwards announced that they had decided to refuse the order.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Anglesey.—The scheme presented by Mr. W. E. Jones, and adopted by the Dwyran District Council, is for a seven-mile 3 feet gauge trolley railway. It will have its northern terminus at Gaerwen, adjoining the London and North-Western Railway Company's main line across the island. Thence it will run to Brynsiencyn, in the parish of Llanidan, and on to Dwyran and Newborough. Between Brynsiencyn and Dwyran will be a junction, with a branch line down to Talyfoel. This is the Anglesey starting place of the ferry-boat to Carnarvon. The scheme provides for the extension of the railway as soon as practicable to Bodorgan, another station on the London and North-Western route, and also to Llanddwyn, on the southern coast of the island. It will follow the roads where they are wide enough, and where the roads will not accommodate it the railway will take to the fields. Generous treatment, it is expected, will be accorded to the undertaking by the landowners, but as to this point the engineer who prepared the plans, Mr. W. E. Jones, the Anglesey county surveyor, and the agent to the Marquis of Anglesey, is, after consulting with the landowners, to report at the next Council meeting.

Bristol.—Notwithstanding the threatening state of the weather until midday on Whit Monday, the Bristol Tramways and Carriage Company, Limited, have cause to be gratified with the result of the day's traffic. The company ran 124 cars and carried 140,885 passengers, as compared with Whit Monday of last year, coming as it did one week later, and after more settled weather, when 121 cars were run and 131,851 passengers were carried, showing an increase this year of 3 cars and 10,034 passengers. The electric lines show their ever-growing popularity by contributing 5,341 of the above increase of passengers.

Bromsgrove.—Messrs. Pritchard & Co., civil engineers, of Birmingham, have formulated a three-mile electric trolley scheme for this district.

Burton-on-Trent.—A Corporation deputation last week visited Bradford and inspected the electric trams, &c., there.

Clontarf and Howth.—On 18th inst., before the Master of the Rolls, at Dublin, in the case of Lord Ardilaun *v.* the Clontarf and Hill of Howth Tramway Company, plaintiff applied for an order restraining defendants from proceeding with the construction of a double line of tramway from Clontarf to Howth in contravention to the terms of the Act authorising the construction of the line, said Act only authorising the making of a single line in front of plaintiff's residence at Dollymount. For the defence it was said that it was not intended to make a double line in front of plaintiff's demesne. The Master of the Rolls granted an injunction restraining the defendants from cutting land for the purposes of making a double line in front of Lord Ardilaun's place.

Dublin.—A Dublin paper understands that owing to the slow progress of the main drainage works the engineer of the tramway company is of opinion that the electric cables cannot be laid in sufficient time to allow of the service of electric trams to Rathmines, Rathgar, Terenure, and Dolphin's Barn being started before December next. The power station at Ringsend is also in a very backward condition.

Dudley.—The Mayor of Dudley states that the Corporation will be prepared to supply the electric current for the tramways as soon as the British Electric Traction Company are ready for it. A few months ago it was feared that would be impossible, and that trouble would ensue. Now, however, all doubt is set at rest. The reconstruction of the tramway line, it may be added, is rapidly approaching completion.

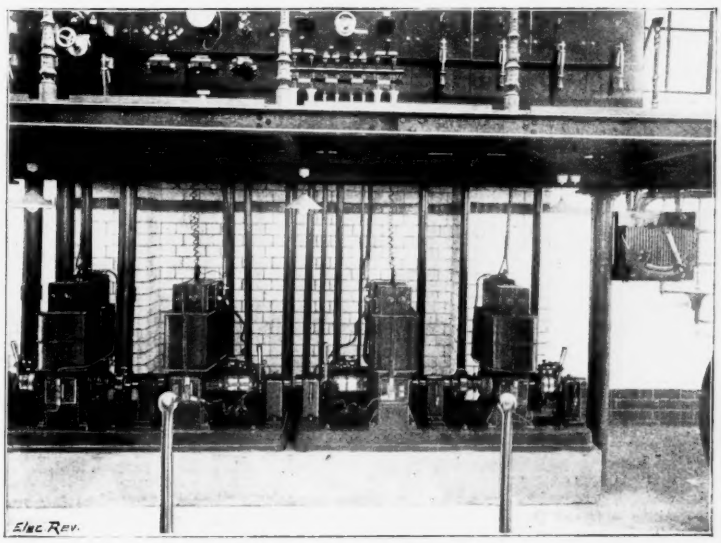
(*Continued on page* 863)

THE POTTERIES ELECTRIC TRAMWAYS.

(*Concluded from page* 818.)

The type of cars adopted on the Potteries lines is the single-decker, the practice being to run a trolley car and trailer together. It may be observed that it would have been impossible to have used double-decked cars, on account of the bridges, which, throughout the district, are exceptionally low. A trolley car and trailer requires, of course, a driver and two conductors, but one advantage presented by the arrangement is that when traffic is light there is no necessity to use a trailer, thus reducing the dead weight to be drawn over the lines.

For operating the service on the section which has been opened, 20 trolley cars and 20 trailers have been provided. Save motor and electrical equipment, the trailers are very similar to the trolley cars, and, if necessary, could be converted. The trolley cars are fitted with two G. E. 800 motors and the usual equipment, the bodies being mounted on Peckham cantilever trucks. The trolley poles are of the Boston pivotal street under-running type, and are practically rigid. One of the most interesting features in the car equipment is the compressed air brake, which is worthy of a detailed description.



View of Negative Boosters.

The complete equipment consists essentially of the following parts :—

1. An air compressor or pump.
2. Its driving mechanism.
3. The casing containing the driving mechanism.
4. A governor, controlling the driving mechanism.
5. A reservoir.
6. A brake cylinder.
7. An operating valve on the head of the brake cylinder.
8. The platform equipment, consisting of operating staff, interlocking handle, and pressure gauge.

The driving mechanism consists of a split gear fastened to the car axle. This gear is in mesh with another gear, which runs free on the pump shaft, and also forms one member of a specially designed combination friction and positive clutch. The clutch members are engaged by means of an automatic governor which will be described later.

The casing is absolutely dust proof, and contains all the above driving parts except the pump and governor, which are bolted rigidly to it. Within the casing and pump is about one gallon of oil. This oil is forced by the rotating gears through all bearings and working parts in the casing and the crank chamber of the pump; and the absence of alternating thrust and pull on the axle bearings, so ruinous to the eccentric driven type, is particularly noticeable through the small amount of oil escaping at the journals.

The pump is double acting, having a piston cast hollow and in one piece, within which is the crank, crank brass, and ways. The bearings, subject to the thrust of the piston are inside, and quite beyond the reach of dust to cut them out. The suction and discharge valves are in the cylinder body, and are provided with removable seats to facilitate repairs. The suction and discharge ports are cored to one inlet and one outlet respectively, making only one connection for the suction and one for the discharge. The heads of the pump are not encumbered with any valves or piping. This construction renders the pump easy of access, as no pipe connections have to be disturbed in examining or cleaning. Under the suction valves are means for lifting them by exhaust air just before the operating mechanism throws the clutch into engagement, thus relieving the latter at that instant of any load, so the strain on the clutch when thrown in contact is practically nothing.

The governor consists of two cylinders of different diameters, in one casting, fitted with two pistons correspondingly, which constitute the operator, the larger piston and cylinder being twice the area of the smaller. The two pistons are also one casting, and in the centre is attached the shipping lever for operating the clutch.

Above, and bolted to the larger cylinder, is the valve chamber of the governor proper, which controls the air to the large cylinder of the operator. Within the valve chamber is a brass slide valve attached to a hollow valve stem, one end of which is a piston, against which the air pressure in the chamber acts in overcoming the pressure of spring within the hollow valve stem.

The air pressure is always in the smaller cylinder, which holds the clutch in contact, and is also at all times in the valve chamber acting on piston against the spring. When the air pressure reaches a predetermined maximum pressure, it overcomes the resistance of the spring and moves the hollow valve stem, which draws with it the slide valve, opening a port which permits the air from the valve chamber to enter the larger cylinder, which, being twice the area of the smaller one, forces the shipping lever in the opposite direction, consequently disengaging the friction clutch, and the pump remains at rest. When the air pressure drops to a predetermined minimum pressure, the air in the valve chamber of the governor has not pressure enough on the

piston on the hollow valve stem to resist the force of the spring, consequently it moves back in the opposite direction, drawing the slide valve with it until it opens the port

View of Interior of Feeder Pillar.

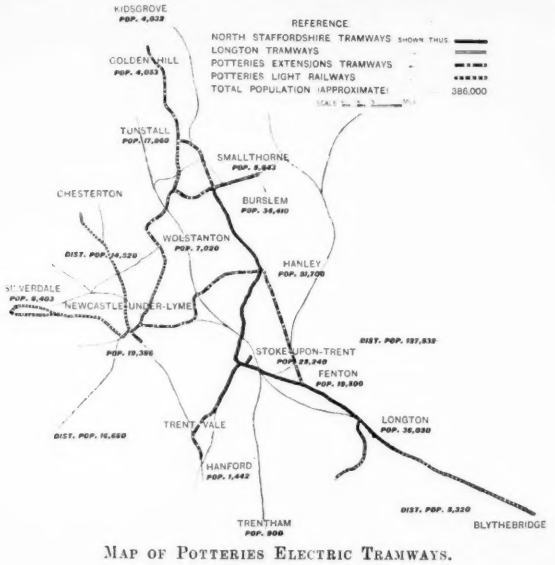
from the large cylinder to the exhaust. The air pressure which held the clutch out of engagement is released, and, since the air pressure is always on the smaller cylinder, this throws the clutch into engagement again, through the shipper lever, and the pump recharges the reservoir to maximum pressure. The reservoir is of the cold weld type, of a suitable size to fulfil the requirements of the service, and is absolutely air-tight.

The brake cylinder is the ordinary hollow spindle type, attached to the floating lever. The leverages on a car are not changed in the least, and the hand brakes can be used just the same as though no air brake were on the car.

The operating valve is bolted to the brake cylinder head, which obviates all piping for this purpose. Formerly it was the custom to place an operating valve on each platform, which required two lines of piping the whole length of the car. In the present method not only is it claimed that the expense is less, but the danger from leaky pipe connections said to be entirely obviated.

The present valve is made with a cast-iron body; within is a brass slide valve, which is moved by means of a steel spindle, having a piston provided with a cup leather. Since the reservoir pressure is always in this valve chamber, it at all times acts on the piston, and holds the slide valve in the "off position." That is, the brake cylinder will always exhaust in the normal position of the operating valve, but when mechanical pressure is applied to the spindle, it pushes the slide valve according to the movement of the spindle. There are three ports under the slide valve, a small port for service stops, a large port for emergency application of the brakes, and an exhaust port. The lap of the slide valve is long enough to cover both the service and emergency ports at the same time. The exhaust passes from the emergency port under the hollow slide valve to the exhaust port, and is carried by piping to the chamber of the governor spring, and also under the suction valves in the pump; and from there it passes by the suction valve "lifts" and out to the atmosphere, through the inlet for the suction. The exhaust from the brake cylinder therefore performs two functions. It lifts the suction valves of the pump so that there is no load when the friction clutch makes its contact. It also in going to the chamber of the governor spring, acts with the latter, and, partially equalising the air pressure on both sides of the piston, the spring forces the hollow valve stem over, and with it the brass slide valve, so that the air in the large cylinder of the governor exhausts, and the clutch is thrown into engagement, and the pump restores to the reservoir the air that was used in making the previous stop, the car having run about 40 feet. By the above operation the maximum pressure is maintained for every application. There is no variation whatever. Of course, after maximum pressure is reached, the governor automatically stops the pump, and it remains so until the next exhaust from the brake cylinder reaches the governor.

The platform equipment consists of a $\frac{3}{4}$-inch cold rolled iron staff, within a piece of 1-inch iron pipe, supported by the dash-rail, in a convenient place and height for the motor man. On top is a pressure gauge, and immediately under it is the handle by which the motor man manipulates the operating valve. This handle moves altogether through an arc of 180°, and the movement is conveyed to the operating valves by means of a rod, chain, and bell crank lever under the floor of the car. By a movement of 90° the service port is opened; by 170° emergency. The instant the handle is released the air pressure on the piston in the operating valve opens the exhaust port. The handle is removed upon changing ends, and the staff remains locked in the release position. By putting the handle in emergency position and withdrawing



Map of Potteries Electric Tramways.

it as far as possible the brake can be left applied. On representative American roads within the city limits the brake is in operation less than one quarter of the time. A good idea is given of the Consolidated Traction Company's line between Jersey City and Newark, known as the "Plank Road." Between the two cities, a distance of about five miles, very few stops are made, averaging about six, so that in 25,000 feet the compressor is in operation a distance not exceeding 400 feet.

The overhead equipment is entirely on the span wire system, and calls for no special comment. In accordance with the usual practice, the system is divided up into lengths approximating to ½-mile, and at these points feeder pillars are placed; these are fitted with switch plugs and fuses, and in addition are supplied with G.E.C. mining telephone sets, by means of which communication can be made with the power house. There are in all 14 feeder pillars provided, with swinging door and a removable panel at the back, which makes them very accessible. The appearance of the interior of one of these pillars is shown in one of our illustrations.

The track has been entirely relaid throughout the system, a rail of 87½ lbs. being used.

All the feeders have been laid on the well-known Callender solid system, and consist of single conductor cables insulated by vulcanised bitumen, and having a heavy tape protection, laid in wooden troughs, which were then filled solid with genuine Trinidad bitumen. The troughs in question were of strong wood, which was thoroughly saturated with Stockholm tar, and made sufficiently large to contain the various feeders.

There are at present four such feeders, viz.:—

No. 1, to Burslem,	·25	sq. in.	sectional area.
No. 2, to Hanley,	·30	"	" "
No. 3, to Stoke,	·35	"	" "
No. 4, to Burslem,	·35	"	" "

Feeders Nos. 2, 3, and 4 are reduced in section along the course of the route, and taper to ·20 and ·10 square inch.

Pilot wires are laid from the generating station to the end of the line at Burslem, at London Road, and Wharf Road, Longton, and there is also telephone circuit to these three places.

The total length of feeder which has been laid is a few yards short of 10 miles, and over 14,000 yards of pilot cable, some consisting of 3, 2, and some of single core 7 22.

There are 18 feeder pillars fixed at intervals half a mile distant from each other, so that the whole tramway is divided into sections as required by the Board of Trade. The telephone cable is also brought into each of these pillars.

In addition to the feeders, a considerable amount of cable has been provided for the negative booster. These are drawn into 4-inch pipes, and the pipe line is partly cast-iron and earthenware. Three cables were drawn into each pipe, and the total quantity of cable used was 12,000 yards of ·25 on the Longton section, and nearly ·125 square inch cable towards Hanley. Spare pipes have also been laid throughout the district to allow for extensions.

The whole of the cable work has been carried out by the Callender Cable and Construction Company, Limited, in charge of Mr. C. A. Noton, who has acted under Mr. George Barnard, the cable company's representative in the Midland district. A large part of the excavation of trenches and of the pipe laying has also been in the hands of this firm.

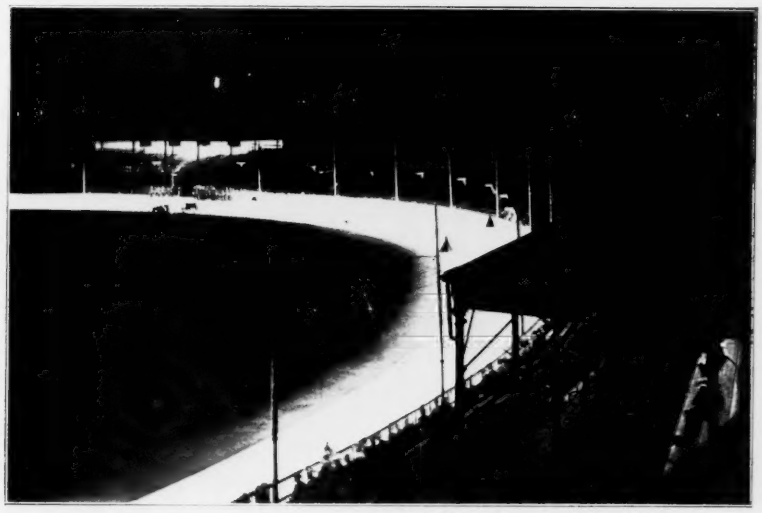
The resident engineer for the Brush Company has been Mr. S. A. M'Hood, acting under the instructions of Mr. R. A. Dawbarn.

Mr. W. Slade Olver was sometime ago appointed managing engineer to the Potteries Electric Traction Company, and we are much indebted to him for assistance in compiling this article.

Cushioned Car Wheels.—A cushioned car wheel for electrical service is described by the *Street Railway Journal*. It is illustrated as placed between the body of a wheel and the tyre. The inside of the tyre is formed of two inclined surfaces which are gripped between the plates forming the two sides of the wheel body, and in the annular V space between the tyre and the plates the cushion is placed. The material of the cushion is not stated, but it would appear necessary to bond the wheel body to the tyre to permit the wheels to form part of a rail return circuit.

THE LIGHTING OF A CYCLE TRACK.

We illustrate an interesting piece of cycle track lighting which has just been completed by Messrs. Crompton & Co., Limited, at Sydney. The Sydney Cycle Track and Grounds, where light amusements of all kinds are engaged in, including cricket, cycle races, firework displays, &c., &c., are now lighted at night by means of inverted arcs. There are altogether 55 arc lamps and 70 incandescents, of which 45 arcs of 2,000-C.P. are placed round the track at intervals of 35 feet, the lamps being inverted with the reflectors immediately over the arc. The grand and ladies' stands are lighted by incandescents. The arc lamps are run six in series off a 300-volt circuit, and we learn that the lighting is in every way a success, there being absolutely no shadows on the track. Some of the leading cyclists in the colony have expressed the opinion that, if anything, it is safer to ride by night under this light than by daylight; at any rate, we are informed that since the lighting has been started there has been a singular absence of accidents on the track. Mr. J. Callender acted as consulting engineer for the work, which was carried out by Messrs. Crompton & Co., Limited, under the supervision of their Sydney manager, Mr. E. J. Erskine. An Australian paper says that the generating plant comprises two engines and four dynamos.



The Lighting of a Cycle Track.

OCEANIC RESEARCH AND THE SUBMARINE TELEGRAPH.

(*Concluded from page* 820.)

For Red Clay of brown or dark grey colour, the percentage of Calcium Carbonate is given as 3 per cent., with one or two bottom-living Foraminifera. A residue (97 per cent.), minerals (1 per cent.), small particles of glass and mica-Siliceous Organisms (1 per cent.) Sponge spicules, Fine Washings (95 per cent.)

For the rest of the deep water Globigerina Ooze principally obtains in the deposits examined. In the lesser depths, generally speaking, Pteropod Ooze, with calcareous casts of organisms.

Pelagic Foraminifera, Coral Mud, and Coral Sand, Coral with Manganese, fragments of Corals, Foraminifera and Molluses, are some of the results of microscopical examination. Blue Mud is found in both shallow and deep water, three specimens, for example, being from 365—672 and 319 fathoms respectively south of Jamaica, and three from depths of 2,388, 2,308 and 2,298 fathoms respectively, to the north of Hayti, on an isolated patch of considerable area, which is apparently surrounded by Coral Mud and Sand.

To the westward of this patch of Blue Mud in the midst of an expanse covered by Coral Mud and Coral Sand, in 2,293 fathoms depth, the only sample of Volcanic Mud met with was found. The detailed description says it is a peculiar deposit consisting of two distinct kinds of material: (1) a fine yellow mud or ooze, with many pelagic Foraminifera; and (2) a green volcanic sandy mud with many mica flakes. The percentage of Calcium Carbonate is given as 19·7 per cent. with pelagic Foraminifera, bottom-living Foraminifera, Pteropod fragments, Tunicate spicules, coccoliths, and Rhabdoliths. A residue (80·3 per cent.), minerals (50 per cent.) Angular m. di. 0·08 mm., volcanic particles, mica, felspar, quartz, glassy particles. Siliceous organisms (1 per cent.) sponge spicules. Fine washings (29·3 per cent.) clayey matter, with minute mineral particles. There was also a little black vegetable matter.

From an inspection of the two samples, Sir John Murray remarks that it is impossible to say whether there were two layers at the bottom, and if so, whether the yellow ooze or the green sandy material formed the upper layer. According to his opinion, it is probable that the bottom was originally covered by Globigerina Ooze, and that subsequently a submarine eruption took place, when the volcanic mineral matter being brought up in such abundance, mixed with the ooze; that it is therefore suggested this deposit must be called a volcanic mud.

This volcanic *débris* is apparently not widespread, the neighbouring deposits being Blue Mud in similar depths to the eastward, and Pteropod Ooze to the westward. Directly north and south of the position indicated, and bounding the Blue Mud and Pteropod Ooze on the east, north, and west, there is shown on the map Coral Mud and Coral Sand.

Of the remarkable sounding in 2,994 fathoms, which is plotted on the map appended to the paper, at about 30 miles to the northward of the Turk's Island Passage, and on the hypothetic dividing limit between the Red Clay and the Globigerina Ooze bottom, no more evidence is forthcoming in the detailed notes on soundings, except that the new snapper came up dented and bent, with but a small specimen of material, consisting of one or two calcareous fragments too minute to determine.

The line of deep soundings has altered the outlines and increased the extent of the area over 3,000 fathoms (called Nare's Deep on the bathymetrical charts published in the summary of results forming the two final volumes of the *Challenger* reports, 1895), which now approaches much closer to the coast of Turk's Islands.

The area over 2,000 fathoms is also extended towards the northern entrance of the Windward Channel between Caicos Bank and Hayti.

It is stated that this series of soundings modifies somewhat the distribution of deep sea deposits, as laid down in this region on the chart accompanying the *Challenger* report on deep sea deposits, published in 1891. Thus

(1) Blue mud is introduced off the coasts of Jamaica and Hayti.

(2) Pterepod Ooze is introduced from Jamaica through the Windward Channel, again off southern entrance of Turk's Island Passage, and again near the island of Bermuda at the northern end of the series.

(3) Coral deposits are introduced off Turks Island, and

(4) The deep water Red Clay area is extended, and approaches closer to the coasts of Turk's Islands than shown on the map referred to.

The interesting, carefully drawn and coloured map accompanying the paper, represents the present state of knowledge concerning the marine deposits in the south western portion of the North Atlantic. The various kinds of deposits are shown in different colours, but it is pointed out that each variety slowly passes into adjacent ones without any marked line of separation, such as the colours on the map tend to suggest.

The Bermudas are shown towards the north eastern corner of the map, and are stated to consist of a number of coral islets which crown the summit of a huge cone rising abruptly from the bed of the ocean, with depths at no great distance of over 2,500 fathoms. This cone was originally, it is said, without doubt, a volcano, but no trace of volcanic rock has as yet been dredged from its slopes. It is now completely covered by a mantle of carbonate of lime, in the form of broken shells and skeletons of marine organisms.

Off the coast of Florida outside the 100 fathom line there is a dark green deposit of glauconite sand and mud, containing about 50 per cent. carbonate of lime. In this deposit some remarkable phosphatic concretions have been found, which, in fact, it is said, occur all through the Straits of Florida, some of them being fragments of Manatee bones.

It is stated that where rivers enter the sea, and off coasts where ancient rock formations are exposed the deposit is usually a Blue Mud, principally made up of land detritus. In the northern part of the Gulf of Mexico, owing to the influence of the Mississippi, and other rivers, Blue Mud is found at great distances from land and in very deep water.

In conclusion, the remark is made that the limits of many of the deposits as laid down on the map, especially in shallow water, are largely hypothetical owing to the small number of deposits which have been carefully examined up to the present time. Future investigations, it is expected, will extend the limits, especially as regards the oozes, coral deposits, Blue Mud and all the shallower water sediments.

A tabulated statement showing mean depths and bottom temperature for different portions of cable as laid is given in the paper, also a table of soundings giving the number, date, position, depth, type of deposit, &c., followed by detailed description of a few of the typical samples representing the different kinds of bottom sediments and a general description of the map, all of which we have summarised in the foregoing *résumé* of the account of this very careful survey.

To cable engineers, and those interested in submarine telegraphy, it is a pleasure to read Mr. Peake's paper and Sir John Murray's addenda. The results detailed show a wonderful advance over old practice in the carrying out of preliminary submarine surveys, and Messrs. Clark, Forde and Taylor are to be congratulated in providing for such a survey in the specifications which were sent out to contractors, while asking for tenders for the laying of the Bermuda-Turk's Island-Jamaica cable.

As usual in all things connected with submarine cables, Lord Kelvin's services have been pre-eminent in this branch. It was through him that such advance in preliminary surveys was rendered possible owing to his introduction, in 1872, of fine pianoforte wire as a sounding line. We are informed that the initiation of extensive preliminary surveying is due principally to the Silvertown Company, who, since 1872, have done a considerable amount of careful work in this direction.

The Roberts Primary Battery.—There are bad times in store for dynamo builders and for the people who build engines to drive generating machinery, if we may believe the information conveyed in the following extract from *Electricity* (New York):—

> It appears that the Chemical Battery, Light, Heat and Power Company, which has just been incorporated at Albany, has been experimenting quietly for several months on a method of producing electricity for commercial use by a process which will dispense with the machinery that has been deemed necessary up to this time. It is held by the officials of the company, as we are informed, that every result accomplished by machinery is reached by this new invention in a noiseless and much more satisfactory and economical manner.

A method of producing electricity in large units which is not only noiseless and more satisfactory, but also *more economical*, than the method at present universally adopted should certainly have a promising future. We are therefore not surprised to learn that the new company is capitalised at rather over £1,000,000. For such an epoch-making invention this is moderate, and shows great modesty on the part of the inventor. The company is organised to manufacture the "Roberts Primary Battery," and also to sell manufacturing rights to secondary and subsidiary companies for foreign countries. We should surmise that the latter will prove the more remunerative field of activity, since no invention is too risky for the modern company promoter, and, as a general rule, the measure of his demands upon the investing public is in inverse ratio to the value of the concession or patent offered for its purchase. We have not yet heard whether the English rights have been sold, but there is certainly opportunity for an enterprise of Hooley-like dimensions, and the promoter fit to cope with it will, no doubt, in due time appear. The slump in electrical engineering and engine companies shares will, however (we are of opinion), not occur just yet.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

(*Continued from page* 858.)

Birkenhead.—At a Council meeting last week, the recommendations of the special Tramways Committee were passed. They reported that the lease of the Birkenhead Tramways Company would expire at the end of next year, and the Corporation, on the payment of about £20,000 to the Wirral Company for the unexpired years of the lease granted to them by the Corporation a few years ago, will retake possession of their lines on January 1st, 1900. To reconstruct all the old lines, and to lay all the contemplated new lines at once, and at the same time, would cause very serious interference and inconvenience. The Committee determined to recommend that tramways and routes, extending a distance of 11½ miles, or thereabouts, shall be laid in the first instance and with the least possible delay:—

(*a*) The New Ferry line, commencing at the Woodside Ferry, and running along Chester Street and New Chester Road, and terminating at New Ferry, at the existing terminus of the Wirral tramways. Distance, 2 miles 4 furlongs 6·22 chains. Single line, with passing places in part, and double line in places. Reconstruction of the existing lines.

(*b*) A tramway line, commencing in Chester Street at the junction of Bridge Street, thence running along Bridge Street, Hamilton Street, Grange Road, and Borough Road, to its junction with Argyle Street South. Distance 4 furlongs 8·08 chains. Double line in part, single line in places. Reconstruction of the existing lines in part, and new lines in other part.

(*c*) A tramway line, commencing at the junction of Borough Road and Argyle Street South, running along Argyle Street South, thence along an intended new road from Argyle Street South to the junction of Holt Hill, Whetstone Lane, and Church Road, where a new street is to be constructed at a cost of £14,300, thence running along Church Road to the junction of Church Road, Bebington Road, and Mount Road. Distance, 1 mile 0 furlongs 6·63 chains. Double line in part, single line in places. New lines throughout.

(*d*) A tramway line, commencing at the junction of Argyle Street South and Borough Road, running along Borough Road to the junction of Borough Road and Prenton Road West, thence running along Prenton Road West by a single line, with passing places to, and terminating at the borough boundary in that road. Distance, 1 mile 5 furlongs 8·40 chains. Double line in part, single line in places. Reconstruction of existing lines in part, and new lines in other part.

(*e*) A tramway line, commencing in Hamilton Street, thence running along the north side of Hamilton Square to Argyle Street, thence running along Argyle Street to its termination at Borough Road. Distance, 4 furlongs 1·46 chains. Double line in part, single line in places. New lines throughout.

(*f*) A tramway line, commencing at the junction of Hamilton Square on its north side, and Argyle Street, thence running along Cleveland Street, Corporation Road, and Beaufort Road, to and terminating at the borough boundary in that road. Distance, 1 mile 6 furlongs 8·13 chains. Double line in part, single line in places. Reconstruction of existing lines in part, and new lines in other part.

(*g*) A tramway line, commencing at the junction of Hamilton Street and Conway Street, thence running along Conway Street, Park Road North, and terminating at the junction of that road with Cavendish Street. Distance, 1 mile 2 furlongs 0·16 chains. Double line in part, single line in places. Reconstruction of existing lines in part, and new lines in other part.

(*h*) A tramway line, commencing at the junction of Conway Street and Claughton Road, thence running along Claughton Road, Park Road South, and terminating at the junction of that road with Park Road West. Distance, 1 mile 0 furlongs 9·02 chains. Double line in part, single line in places. Reconstruction of existing lines in part, and new lines in other part.

(*i*) A tramway line, commencing at the junction of Conway Street and Camden Street, thence running along Camden Street and terminating at the junction of that street with Claughton Road. Distance, 6·30 chains. Single line throughout. New line throughout.

(*j*) A tramway line, commencing at the junction of Balls Road East and Borough Road, thence proceeding along Balls Road East, Balls Road, Shrewsbury Road South, and terminating in that road at its junction with Beresford Road. Distance, 7 furlongs 2·16 chains. Double line in part, single line in places. New line throughout.

Girder rails of 100 lbs. per lineal yard will be necessary. Thirteen single deck composite cars, and 31 double deckers (Messrs. Milnes's pattern) are to be ordered. Vacant land in Craven Street is to be utilised for a generating station, adjoining the present electric works, with an additional station for the New Ferry service adjoining the refuse destructor in New Chester Road. The committee recommend centre poles, with brackets to carry the overhead wires. The estimated cost of road laying, electrical plant, cars, &c., is as follows:—

The borough engineer's estimate is as follows:—Laying new tracks and reconstructing old tracks as set out in scheme: Single line, 6 miles 1·73 chains, and double line, 5 miles 5 furlongs 7·79 chains, £96,439 11s. 8d; loops into car sheds, crossovers, &c., £2,000; buildings for electricity generating stations, £13,750; land and buildings for car sheds, waiting rooms, &c., £15,450; general expenses, £1,750; total, £129,389 11s. 8d.

Electrical engineer's estimate:—Craven Street plant: Boilers, engines, dynamos, &c., as specified, £21,475; South End destructor depôt plant: boilers, engines, dynamos, &c., as specified, £9,587; electric line work: standards, trolley wire, feeder mains, rail bonding, and return feeder: double track 5 miles 5 furlongs 7·79 chains, £11,232 5s. 8d.; single track (including car sheds) 6 miles 4 furlongs 1·73 chains, £10,604 2s. 6d.; cars: 31 double deck cars and 13 single deck (composite) cars at £600 each, £26,400; total, £79,289 8s. 2d. Total, £208,678 19s. 10d., excluding the cost of the new street across Argyle Street Hill.

The report was adopted, and the following, who were members of the special committee, were appointed a Standing Tramways Committee:—Aldermen Bloor, Deakin, Rawcliffe, Shaw, Singleton, and Smith; Councillors T. Cook, Gamlin, Hazzlehurst, B. Jones, Kelly, Kenny, Oates, Rees, and Snape.

East Ham.—At last week's District Council a committee reported having fully considered the original and supplementary reports of the electrical engineer on the electric lighting and electric tramways for the district, and recommended (*a*) That the generating station and tramway depôt be erected on a portion of the public offices site; (*b*) That the reports be received and adopted, and the various recommendations contained therein be carried into effect. Councillor Edwards thought the matter should be referred back for consideration. By adopting the committee's recommendation they pledged themselves to the overhead system. Councillor Bethell thought before the Council prepared themselves to spend about £100,000 they should have every information. He thought they might wait and learn the result of Prof. Kennedy's visit to New York. In the meantime, members of the Council could be supplied with the latest information on the subject. Councillor Anderson said the Council had decided upon the overhead system. He seconded the motion that it be referred back. Councillor Long said the committee had gone into the matter thoroughly, and had been supplied with a large amount of information. It was unanimously agreed that 99 per cent. were in favour of the overhead system. Councillor Brooks moved, as an amendment, that the matter be considered by the Council in committee that night after the ordinary business. The amendment was carried.

Huddersfield.—The Tramways Committee's recommendations mentioned in last week's issue have been passed by the Council.

Light Railways.—The *London Gazette* for 23rd inst. contains notices regarding the following applications for light railway powers:—

Power and Traction, Limited: Oakington and Cottenham line.

Escrick and Riccall Rural District Councils: Derwent Valley line.

Hornsey Urban District Council: Hornsey and Islington lines.

Finchley Urban District Council: Hornsey and Finchley lines.

Bishops Waltham Light Railway Company: Lines between Bishops Waltham and Meon Valley Railway.

Nelson Town Council: Standard gauge electrical lines in Nelson and district.

Bourne Valley line, promoted by a company.

Nuneaton and District Light Railway Company: Light railways in Nuneaton and district.

London and South-Western Railway: Basingstoke and Alton light railway.

Liverpool.—The City engineer and the general manager of the tramways have been instructed by the Tramways Committee to report as to the extension of the electric system to Aintree and Fazakerley, and the manager has been requested to consider the advisability of applying for powers to extend the tramways beyond the city boundaries.

London.—At the Hammersmith Vestry on Wednesday it was reported that the London County Council has given their consent to the London United Tramways, Limited, to reconstruct, in accordance with the overhead trolley system of electrical traction, the tramways in the parish. It was decided to give consent to the working by the company of the lines upon terms detailed by the London County Council, and some additional conditions as to the company bearing the expense of altering the roads, the Vestry's costs in connection with the company's bills, &c.

Newcastle.—A sub-committee of the Tramways Committee last week drew up a scheme of sections of the new tramways. One section will be from Scotswood to Byker, instead of to Gosforth as at present. Another will be from Westmorland Road to Walker Road by City Road. A third from the Monument by Spital Tongues to Brighton Grove. A fourth from the Monument by Blackett Street and Clayton Street to Arthur's Hill and Elswick Road terminus. A fifth to the Arthur's Hill terminus by Stanhope Street. A sixth between the station and Gosforth, and also from the station to Jesmond and Osborne Road end. It is contemplated that each section will be worked on 1d. fares.

Oldham.—An Oldham paper says that arrangements for the opening of the electric trolley tramway line from Hathershaw (Oldham) to Ashton are now practically settled, and the cars were expected to commence running on Wednesday.

Pontypridd.—The British Electric Traction Company is applying to the Light Railway Commissioners for powers for an extension of the present tramroad from Porth from the terminus at Pontypridd in the direction of Cilfynydd. Mr. Sellon, the company's Parliamentary engineer, is seeking an interview with the Council on the subject.

Portsmouth.—The Tramways Committee, who are making arrangements in connection with the approaching transfer of the local system to the municipal body, have held a meeting, at which the chairman (Mr. H. Kimber, ex-mayor) and vice-chairman reported having visited Glasgow and Liverpool. Details were given of the arrangements which are being made in the former city for equipping the whole of the service for electric traction. At Liverpool the electricity is supplied by the Corporation Electric Lighting Committee at nine-tenths of a penny per unit. The Committee provides feeders and section boxes and all materials up to the foot of the standards. Replies had been received from 20 towns respecting the system adopted in carrying on the work of reconstruction of tramways, and in the majority of these towns it was found that plans and specifications were prepared by their own borough engineers and electrical engineers' staff. "This course (the chairman and vice-chairman further reported) cannot be carried out by the borough engineer's staff here (in its present strength) as regards the permanent way. With reference to the electrical equipment of the service we are not in a position to say, but feel it to be a question to be decided by the electrical department. If not carried out by this department, the only course is to appoint an expert to prepare plans and specification, and superintend construction at an inclusive fee, or to employ an expert to prepare plans and specification, which would become the property of the Corporation. Taking all surroundings into consideration, we are of opinion that an expert

should be engaged, at an inclusive fee to cover all cost of preparing plans and specification, the Corporation to appoint some one to superintend the work, and, if found capable, to be appointed general manager." The Committee decided to recommend the appointment of an expert to prepare plans for the adoption of the overhead wire system, payment to be made by a fixed fee. It is also proposed to appoint a clerk of works, to be eventually made general manager, in the event of his proving competent to discharge the duties satisfactorily.

TELEGRAPH AND TELEPHONE NOTES.

The Excessive Rates Charged on Indian Telegrams.—We learn that Mr. Henniker Heaton is very busy organising his Imperial Telegraph Committee which has for its object the improvement of the existing lines to the East, thus cheapening and popularising this means of communication. The project, we learn, is attracting much attention, and a deputation, which will shortly wait on Mr. Balfour, promises to be attended by many of the most representative men in the city.

The Pacific Cable Question.—The Ottawa correspondent of the *Times* telegraphs that, since the text of the Colonial Office letter of April 28th on the Pacific cable question was received, the Canadian Press has been criticising it very severely, pointing out that, in all the circumstances, the despatch was unworthy of the British Government. It is urged that the conditions laid down by the Imperial Government combine the *minimum* of advantages to the Mother country with the *maximum* of expenses to the Colonies and the *maximum* of delay to the cable, and are, therefore, of the greatest benefit to the existing monopoly.

We also learn that Sir George Turner, the Premier of Victoria, has sent a cablegram to Lieutenant-General Sir Andrew Clarke, the Agent-General for Victoria in London, expressing the disappointment of the colony at the refusal of the British Government to share in the cost of the construction of the projected Pacific cable.

The Cabinet of New South Wales has also considered this question, and dissents from the view of the Imperial Government on the subject, agreeing with Canada, Victoria and Queensland, that the cable should be jointly owned and not subsidised. This decision was communicated to the other colonies. The *Daily Chronicle* publishes the following letter from Prof. Ayrton, who calls attention to the real "pioneer" cable to the East:—

"Sir,—The linking together of Great Britain, Canada, Australia, and New Zealand by the joint ownership of a Pacific cable would constitute an important Imperial development. I write to suggest that, in coming to the conclusion that Great Britain is too poor to take part in so important an enterprise, the Government has perhaps overlooked a fact in cable finance, viz, that in 1908 there will come to an end the subsidy of £36,000 a year, which, for the past 40 years, we have been paying for a Red Sea cable, through the entire length of which no message was ever sent, and which, as a matter of fact, was never even laid.

"Placed in the sea it was, but not on the bottom, for, in order that the contractors might save for themselves as much surplus cable as possible, they were allowed to draw it so taut, that when the late Mr. Latimer Clark went to look for this cable in 1862, he could not find a single piece as long as 100 miles.

"Now, as our Government has not hesitated to spend already a million and a half to benefit the owners of this non-existent cable, is it too much to ask them to continue the yearly payment for the benefit alike of Great and Greater Britain?—I am, &c.,

"W. E. Ayrton.

"Central Technical College, Exhibition Road,
May 18th.

"[Is this not the subsidy payable in respect of the present cables of the Eastern system, of which four run between Suez and Aden, two touching at Suakim?—Ed. *D.C.*]"

In reference to the editorial footnote, we may say that the subsidy does not apply to any existing cable, as the cables broke down section by section after being laid, but after each section was tested. No message ever went through the entire length of this group of cables.

We are glad to learn that the Government are now re-considering their decision as to the way in which they will support the Pacific cable scheme, and we hope soon to learn that they have fallen into line with the Colonies on this subject.

The Telephone Question.—Mr. E. W. I. Peterson, of 56, Lincoln's Inn Fields, writes to the *Times* with reference to the recent announcement that the National Telephone Company had made an important modification in the rates for exchange telephone service in the County of London, the directors having decided "that the ordinary tariff rates are to apply generally throughout the County of London without regard to distance, so that any person whose residence is situated within the county will be enabled to obtain the telephone service throughout for £10 per annum." It was added that "the company anticipate that this decision will prove of material benefit to many householders." Mr. Peterson states that, being charged £17 5s, he wrote to the company as to the published announcement, and received the following reply:—"Dear Sir,—In reply to the letter of 16th inst., the paper to which you refer has apparently been misinformed. The £10 rate refers to private houses only, and applies to the County of London as distinguished from what was previously known as the National Telephone Company's inner London area. Any private residence in the County of London can be connected at £10 per annum on a five years' agreement. Yours faithfully, W. M. Morten, district manager." The *Times* responds that the statement published was sent to it for publication on behalf of the National Telephone Company.

The Telephone Service.—It is stated that Mr. Provand, M.P., has sent a memorial, signed by about 100 members of Parliament, urging that an early day should be fixed for the second reading of the Government Telephones Bill.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Amazon Company's cable—		
Cable beyond Gurupa ...	June 11th, 1898 ...	...
Eastern Telegraph Co.'s cable—		
Ilo Ilo-Bacolod	May 5th, 1899 ...	May 21st, 1899
Para-Maranham	April 10th, 1899 ...	...
Assab-Massaouah	May 23rd, 1899 ...	...
French Company's cable—		
Paramaribo - Cayenne (for repairs)	May 19th, 1899 ...	May 19th, 1899
Landlines.		
Communication between Mossamedes and all Inland Offices.	March 16th, 1899 ...	...
Communication between Salonique and Monastir.	March 23rd, 1899 ...	...
Line between Antofagasta and Cochabambu (Bolivia)	May 9th, 1899 ...	...
Communication with Swakopmund	May 18th, 1899 ...	...
Siberian lines between Riddeard Khabarowko,	May 18th, 1899 ...	May 19th, 1899
and Sretenskaia and Albazine	May 23rd, 1899 ...	May 23rd, 1899
Fao lines between Diarlekir and Bagdad	May 18th, 1899 ...	May 20th, 1899
Communication with Port au Prince and Jacmel (Hayti)	May 17th, 1899 ...	May 23rd, 1899
Communication with Jérémié and Port de Paix (Hayti)	May 20th, 1899 ...	...

Wireless Telegraphy.—Mr. Henniker Heaton on 18th inst. entertained Mr. Marconi at dinner at the House of Commons. It is understood, says the *Standard*, that Mr. Marconi will shortly be able to announce some fresh developments of his inventions in connection with wireless telegraphy. Among these is an arrangement by which a vessel, with the proper apparatus on board, will, on approaching rocks in which a lighthouse is situated, be automatically warned of the danger in which she is placed, in spite of any fog which may exist at the moment.

CONTRACTS OPEN AND CLOSED.

OPEN.

Barton-upon-Irwell.—June 6th. The Guardians want tenders for the wiring and fitting of their new infirmary buildings, Green Lane, Patricroft. Specifications, &c, from Mr. G. R. Peers, consulting engineer, 96, Deansgate, Manchester.

Battersea.—June 7th. The Vestry wants tenders for the supply of mains, water-tube boilers, steam dynamos and engines. See "Official Notices" April 14th.

Bexley (Kent).—May 31st. The L.C.C. Asylums Committee is wanting tenders for the installation of telephones, fire alarms, tell-tale clocks, and call bells at the Heath Asylum, Bexley, Kent. Instructions, &c., can be obtained from Mr. R. W. Partridge, clerk of the Asylum Committee, 6, Waterloo Place, S.W.

Birkenhead.—May 26th. The Corporation wants tenders for the supply and delivery of 100 electric meters. See "Official Notices" May 5th.

Birkenhead.—June 9th. The Corporation wants tenders for one 225-kw. direct current high speed steam dynamo. See "Official Notices" May 19th.

Brighton.—May 29th. The Council wants tenders for the supply of auxiliary switchboards and switchboard gallery at the electricity works. See "Official Notices" May 12th.

Crewe.—June 1st. The Corporation wants tenders for boilers and economisers, engines and dynamos, centrifugal pump and motor, mains, battery, switchboard, and travelling crane. See "Official Notices" May 5th.

Dudley.—June 17th. The Electric Lighting Committee wants tenders for water-tube boilers, economiser, steam dynamos, balancers, switchboard, cables and street work, arc lamps, and travelling crane. See "Official Notices" May 19th.

France.—June 3rd. The French Post and Telegraph Authorities in Paris are inviting tenders until June 3rd for the supply of 16 lots of telegraphic apparatus. Particulars may be obtained from, and tenders are to be sent to, Le Sous Secretariat d'Etat des Postes et Telegraphes, Rue de Grenelle, 103, Paris.

Gloucester.—We understand that the Gloucester Railway Carriage and Waggon Company, Limited, are asking for tenders for fitting their works with electric apparatus, as the directors have decided on having electric transmission of power for the whole of the works.

Hackney.—June 13th. The Vestry invites tenders for trenching, troughing, cables, joint boxes, jointing and house services. See "Official Notices" May 5th.

Halifax.—May 26th. The Corporation wants tenders for 100 tons of 2-inch and 2½-inch cast-iron pipe. See "Official Notices" May 12th.

Islington.—June 1st. The Guardians of the Poor of St. Mary, Islington, invite tenders from persons prepared to carry out the necessary works for the installation of the electric light at the New Infirmary for the Parish at Highgate Hill. Further information, copies of plans, &c., from Mr. W. Smith, architect, 65, Chancery Lane, W.C.

Kertch.—The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul at Taganrog, stating that tenders are invited by the municipality of Kertch for the supply of materials for the construction of electric lighting plant and tramways in that town.

Manchester.—June 3rd. The Art Gallery Committee wants tenders for an electric installation at the City Art Gallery, Mosley Street. Particulars from the City Surveyor.

Sheffield.—June 5th. The Health Committee is inviting tenders for engines, electric lighting plant, pumps, shaftings, pulleys, and other engineering work required at the destructor. Particulars and specifications from the City Surveyor (Mr. Wikes), Town Hall, on payment of one guinea, returnable as usual.

Southampton.—June 5th. The Corporation wants tenders for motor cars and equipment, and the electrical equipment of lines. See "Official Notices" May 12th.

Spain.—June 2nd. Tenders are being invited until June 2nd by the municipal authorities of Medina-Sidonia (Cadiz), for the concession for the electric lighting of the town during a period of 20 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Medina-Sidonia (Cadiz).

Spain.—June 8th. The Spanish Post and Telegraph Authorities in Madrid are inviting tenders until June 8th for the supply of 26,000 zinc cylinders for telegraph batteries. Particulars may be obtained from, and tenders are to be sent to, El Direccion General de Correos y Telegrafos, Calle Carretas 10, Madrid.

Spain.—June 25th. Tenders are being invited until June 25th by the municipal authorities of Alcala la Real (province of Jaen), for the concession for the electric lighting of the town during a period of three years. Particulars may be obtained from, and tenders to be sent to, El Secretario del Ayuntamiento de Alcala la Real (Jaen).

Teneriffe.—June 14th. Tenders are being invited until June 14th by the Spanish Ministry of Public Works in Madrid for the concession for the construction and working of an electric tramway between Santa Cruz de Teneriffe and San Cristobal de la Laguna, Teneriffe. Tenders to be sent to La Direccion General de Obras Publicas (Ministerio de Fomento), Madrid, whence particulars may also be obtained.

West Africa.—July 10th. The Compagnie de Mozambique, of 45, Rue do Alecrim, Lisbon, is inviting tenders until July 10th for the concession for the establishment and working of a central electric power station at Beira for lighting and power purposes during a period of 25 years. Particulars from, and tenders to, above.

York.—June 5th. The North-Eastern Railway want tenders for telegraph apparatus, wire and line stores. Particulars from Mr. Graves, Telegraph Department, York.

CLOSED.

Beckenham.—The tenders received by the Council for dust destructors were as follows:—Beaman & Deas, £1,685; Manlove, Alliott & Co., £1,220; Goddard, Massey & Warner, £1,154 10s.; Horsfall Furnace Syndicate, £1,107; W. F. Mason and Co., £768. Messrs. Horsfall's tender was accepted.

France.—The French Post and Telegraph Authorities has placed the contract for the supply of 280 kilometres of paper-insulated telephone cable with the Société Alsacienne de Construction Mécaniques, of Belfort, at 510 francs per kilometre.

South Shields.—The Corporation has accepted a tender of Mr. T. Lumsden, of Jarrow, for extending the electricity works' buildings at a cost of £2,296.

FORTHCOMING EVENTS.

Friday, May 26th.—At 10.30 a.m. Institution of Mining Engineers. (Second Day.) Among other papers will be one on "A New Process of Seasoning and Preserving Timber and other Fibrous Substances by means of Electricity," by Mr. H. Baillie-Weaver. Among those open for discussion is one on "Experiments on the Ignition of Fire-damp and Coal-dust by Means of Electricity," by Messrs. Heise and Thiem.

At 5 p.m.—Physical Society, at the rooms of the Chemical Society, Burlington House. Agenda:—(1) "On the Thermal Properties of Normal Pentane."—Part II., by Prof. S. Young and Mr. Rose-Innes; (2) "On the Distribution of Magnetic Induction in a Long Iron Bar," by Mr. C. G. Lamb.

Wednesday, June 7th (also 8th and 9th).—Institution of Civil Engineers. Engineering Conference at Great George Street, S.W.

Wednesday, June 14th (also 15th, 16th, and 17th). Convention of the Municipal Electrical Association at Bristol.

Friday, June 30th.—At 8 p.m. Röntgen Society, at 11, Chandos Street, Cavendish Square. Paper by Mr. A. W. Isenthal on "Short Notes on the Wehnelt Electrolytic Breaker"; Notes by Mr. H. W. Cox, on the same subject; also by Messrs. Apps and Wilson Noble.

NOTES.

Our Leading Article.—In the fourth paragraph of the first column on page 842, "The first question which arose, &c.," should read, "The first question which arose in the case before Mr. Justice Cozens-Hardy."

New Systems of Motive Power.—In our issue of June 17th last we made a reference to the Guattari system of steam raising which was being exploited by the New Motive Power Syndicate, and of which a demonstration plant, consisting of a compound Davey-Paxman engine and two Davey-Paxman locomotive type boilers, had been laid down in Camberwell at a place off Heron Road, near Loughborough Junction. The Guattari system, which was patented, was for combining with the water in a steam boiler a proportion of ethylene chloride, or Dutch liquid, and carbonic acid gas. Tests carried out by Sir Samuel Canning and Mr. Gatehouse, assisted by Mr. W. H. Booth and Mr. J. Christie, demonstrated that there was no advantage in the system. The matter finally reached the Law Courts, and the report that was made was upheld by Mr. Justice Bigham, and it was thought at the time that the Guattari system had been fully shown to be based on erroneous data. From information which has reached us, we are afraid that there is being made an attempt to again interest the public in this invention. We cannot speak positively on the subject, but if it is so we would advise anybody who may be asked to support any system of charging water with carbonic acid gas, &c., with a view to reducing the boiling point or producing some other mysterious change, to make diligent and careful inquiry as to whether what is offered for their consideration be or be not the old Guattari patent in some new form or under a different guise. When we say that an evaporation of over 16 lbs. of water per lb. of coal was claimed for the Guattari system, we have said enough to show that extreme caution should be exercised by anyone in taking up the affair. Needless to say, anyone who really caused 16 lbs. of water to be evaporated per lb. of coal would be crushed under the load of wealth which would accrue to him. *Verb. Sap.*

Lectures.—On 18th inst. Prof. Emerson Reynolds, F.R.S., lectured on "Discoveries made by means of the Electric Furnace," at the Chemical Theatre, of Trinity College, Dublin. On Thursday last week Sir W. C. Roberts-Austen lectured, with experiments, upon the electric furnace, before the Vesey Club, Birmingham.

Before the Ipswich Scientific Society last week, Mr. S. A. Notcutt lectured on "Wireless Telegraphy." Prof. W. H. Heaton, M.A., also lectured on the same subject at the Nottingham University College last week.

The Copper Market.—Messrs. H. R. Merton & Co.'s mid-monthly circular relating to copper discloses such an anomalous state of affairs that we feel it necessary to draw attention to it without waiting for the full returns for the month of May. The supplies for the first half of May have only totalled 8,210 tons, a deficiency of 1,350 tons when compared with the average for the preceding 12 months. This deficiency is wholly due to the decreased shipment from North America, which have equalled only 2,052 tons, as against an average of 5,260 tons for the 12 months preceeding. The deliveries during the first half of May have shown a similar shrinkage, the total being 7,582 tons as compared with an average of 9,500 tons for the 12 months ending April 30th. The high price to which copper has been forced by the action of interested parties is therefore producing its natural effect in the restriction of consumption, and the shrinkage of supplies is merely an effort by the larger stockholders in America to accommodate the shipments from New York and Baltimore to the conditions of the London market. We hope circumstances may compel them to continue this policy, so unpleasant to themselves, of stocking copper instead of selling it, until the market breaks and prices attain a more normal level. At present the price still rises, and although the amount of copper in English and French ports, and afloat thereto, has increased by over 500 tons, during the first half of May the price of G.M.B.'s has advanced 30s., and on May 15th stood at £78 10s. We consider that during the present reign of high prices it will be of advantage to give in each report the ratio between the cost of copper and aluminium for conductors of equal length and equal carrying capacity. The ratio at the advance of 30s. per ton since our last calculation is now expressed by

$$\frac{8{\cdot}93 \times 8{\cdot}81 \times 59}{2{\cdot}68 \times 14{\cdot}5 \times 100} = \frac{4{,}641}{3{,}886} = \frac{119}{100}.*$$

Electrical engineers would, therefore, do well to look after supplies of aluminium. The American papers which have recently come to hand, contain the details of the incorporation of the Amalgamated Copper Company on April 27th. We take the following from the issue of the *Engineering and Mining Journal* for April 29th:—

The Amalgamated Copper Company, with a capital of $75,000,000, filed articles of incorporation at Trenton, N J, April 27th. The company is empowered to mine, smelt and mill copper ore and to produce copper, gold, silver and other metals. It can also buy and sell, build and erect plants, and acquire properties. At a meeting of the company in Jersey City, these directors were chosen:—Henry H. Rogers, William G. Rockefeller, Marcus Daly, Frederick P. Olcott, James Stillman, Roswell P. Flower, Robert Bacon, and Albert C. Burrage. At a subsequent meeting of the directors, the following officers were elected:—President, Marcus Daly; vice-president, Henry H. Rogers; secretary and treasurer, William G. Rockefeller; executive committee, Henry H. Rogers, William G. Rockefeller, and Albert C. Burrage. This is evidently the organisation which is to hold and operate the copper properties lately acquired by the Standard Oil people. These include the Boston and Montana, the Butte and Boston, the Parrot and the Anaconda in Montana; the Arcadian and the Isle Royale in the Lake Superior region. It is understood, also, that the combination includes the Washoe copper properties at Butte, owned by Messrs. Daly & Haggin. These have not been heretofore mentioned in this connection.

It is currently reported in New York that efforts are still being made by the syndicate to obtain control of other mines, but it is generally believed that these efforts will fail.

Royal Institution.—On Monday the following foreign scientific men were elected honorary members in commemoration of the centenary of the Institution, which will be celebrated on June 5th, 6th and 7th:—

Prof. S. Arrhenius (Stockholm), Prof. C. Barus (Brown University), Prof. H. Becquerel (Paris), Prof. G. L. Ciamician (Bologna), Prof. N. Egoros (St. Petersburg), Prof. A. P. N. Franchimont (Leiden), Prof. A. E Gautier (Paris), Prof. H. G. Kayser (Bonn), Prof. W. Korner (Milan), Mr. S. P. Langley (Washington), Prof. G. Van der Mensbrugghe (Ghent), Prof. A. A. Michelson (Chicago), Prof. H. Moissan (Paris), Prof. R Nasini (Padua), Prof. W. Nernst (Gottingen), Prof. W. Ostwald (Leipzig), Dr. E. Solvay (Brussels), Prof. R. Tourston (Cornell), Prof. E. Villari (Naples), Prof. J. L. G. Violle (Paris), Dr. E. Ador (Geneva), Dr. L. Bleekrode (The Hague), Prof. J. S. Ames (John Hopkins University), Prof. G. F. Barker (Philadelphia), Geheimrath Professor Dr. Liebreich (Berlin), and Dr. W. L. Wilson (Washington).

* For details of this formula see ELECTRICAL REVIEW for September 2nd, 1898.

Municipal Electrical Association.—Brief reference was made in our last issue to the forthcoming convention of the above Association, which opens at Bristol on Wednesday, June 14th. The meetings are this year to be open to visitors, instead of being confined as in previous years to those who have received special invitation cards. The complete programme of proceedings is as follows:—

Wednesday, June 14th.—Museum Lecture Theatre, Museum Road, 9.45 a.m., the Right Worshipful the Mayor of Bristol will welcome the Association to the city. Presidential address by Mr. H. Faraday Proctor, city electrical engineer, Bristol.

PAPERS FOR DISCUSSION.

"Municipal Trading," by Councillor George Pearson, chairman of the Electricity Committee of the Bristol Corporation.

"Appropriation of Profits," by Bailie Maclay, convener of the Electricity Committee of the Glasgow Corporation.

Members or visitors taking part in the discussions are requested upon rising to speak to mention their name and the town or firm they represent.

Luncheon at the Royal Hotel, College Green, by special invitation of Mr. George Pearson, to be followed by a visit to Cheltenham Electricity and Dust Destructor Works of the Cheltenham Corporation.

Thursday, June 15th.—"Combined Lighting and Traction Works," by Mr. J. H. Rider, borough electrical engineer, Plymouth.

"The Municipalisation of Telephones," by Mr. A. B. Mountain, borough electrical engineer, Huddersfield.

"House-to-House Distribution of Electricity," by Mr. C. D. Taite, borough electrical engineer, Southport.

Visits to Bath electricity works, Bristol electric tramways, to be followed by the Association dinner at the Grand Hotel, College Green.

Friday, June 16th.—"Condensing Appliances," by Mr. J. F. C. Snell, borough electrical engineer, Sunderland.

"Steam Pipes, Fittings, and their Arrangement," by Mr. J. E. Edgcome, borough electrical engineer, Kingston-on-Thames.

Garden party at Cook's Folly, Sneyd Park, by special invitation of the Mayor of Bristol.

Visit to the Bristol electricity works, Temple Back.

Works open for inspection.—The Great Western Railway Works, Swindon; the Bristol Waggon and Carriage Company's Works, Lawrence Hill; Messrs. Peckett & Sons' Locomotive Works, St. George; Messrs. Humpage, Jacques & Pedersen, Machine Tools and Helical Gearing, Ashton Gate.

Saturday, June 17th.—Business meeting for election of president, &c., &c.

Visit to Tintern Abbey.

The Copyright Law.—Mr. J. Slater Lewis was among those who gave evidence last week before the House of Lords Select Committee which is considering the proposed amendment to the copyright law in relation to literary and artistic works. Lord Monkswell, who has introduced two Bills into Parliament on the subject, presided.

Mr. Slater Lewis stated that he had had a very wide experience as the manager of engineering works, and was the author of a book entitled "The Commercial Organisation of Factories." He was engaged some four or five years in writing the book, which was the first work to cover the whole of this subject. A great deal of the matter it contained was based on personal experience, and some of the forms he used were absolutely original and unique. Some time afterwards one of the engineering papers published a series of articles on the same subject, and these articles were subsequently embodied in a book with the title "The Commercial Management of Engineering Works." In this book there were 109 paragraphs, in which were phrases taken from his work on the same subject, and in addition, some of the forms were also copied. He instituted proceedings for infringement of copyright, and the action was heard in March last by Mr. Justice Cozens-Hardy, who said that there was no doubt that use had been made of his book in the subsequent work, but held that it was not to such an extent as to constitute an infringement. The judge further pointed out that there was no copyright in ideas, but only in form.

[At this point Lord Monkswell read Mr. Justice Cozens-Hardy's judgment in full.]

Viscount Knutsford asked the witness to suggest how any legislation could meet such a case as his. It must, he presumed, always lie with the judge to say whether any particular extracts were fair or not, and he (Viscount Knutsford) could understand that on the facts of his case another judge might have come to another decision.

The witness suggested that it should be held to be an infringement if one writer used exactly the same words and phrases as a previous writer in dealing with the same subject. If the source of the extracts were properly acknowledged it would make a great difference.

Viscount Knutsford: Are you going to appeal?

The Witness: I cannot afford it. It has cost me £300 already for costs in the last action, and that is more than I get for the book.

The Chairman asked if the witness had any definite clause in his mind which he would suggest should be inserted in the Bill dealing with literary copyright.

The Witness said he had not. He would not have objected at all if the writer of whom he complained had only acknowledged the source from which the phrases and forms had been taken, but there was no acknowledgment made of any kind.

Neugschwender's Anti-Coherer. — Some time ago Neugschwender made the curious discovery that a film of moisture produced by breathing on a scratch in the silver coating of a mirror was sensitive to the action of electric waves, but in an opposite sense to Branly's coherer. When a small electric current was flowing through the film of moisture, the impact of the electric waves caused the current to stop; but the current started again as soon as the electric waves stopped. Neugschwender has made an exhaustive investigation to discover the cause of this curious phenomenon, the results of which are published in *Wied. Ann.*, Vol. 68, p. 92. In one case the resistance of a film of moisture was raised from 50 ohms to 90,000 ohms by the impact of the electric waves, the scratch in this case being 20 mm. long and $\frac{1}{3}$ mm. wide. It was found that the conductivity was not destroyed by evaporating the film of moisture, as might have been expected, and this led Neugschwender to suspect that metal salts dissolved in the moisture had something to do with the phenomenon. When the heat was continued after complete evaporation till the metal salts were fused, the electric waves still re-acted in the same way. A number of different electrolytes were tested, and many, though not all, acted as anti-coherers; the exceptions were those in which no free metal was separated on the electrodes. When the scratch was examined under the microscope it could be seen that the passage of the current caused minute metallic "trees" to grow on the cathode. As soon as the film was struck by the electric waves these trees were broken to pieces, but immediately thereafter began to grow again. It looked, therefore, as if the conductivity of the film was due to metallic threads projected across the gap by electrolysis, the reduction of their conductivity being due to their destruction by the electric waves.

Electrical Omnibus in Berlin.—The *Standard* Berlin correspondent says that the committee of the Motor-car Exhibition, to be held in Berlin next September, made a trial of a motor-omnibus on 17th inst. The course, about two miles in length, was from the Reichstag Hall to the Charlottenburg, and the run occupied 25 minutes. The omnibus is driven by two motors, which work by means of cogwheel gear on the hind wheels, and are fed by electricity. The carriage, which is built like a tramcar, has 12 seats and standing room for six persons at the back. The accumulators are fixed under the seats, and have a capacity sufficient for 20 kilometres. They can be automatically recharged at fixed intervals. The carriage is steered by a handle, and is also provided with a mechanical fly-brake and an electric brake. The electric brake brings the carriage to a standstill in 1·5 metres when going at full speed. The weight is 3,500 kilogrammes. The cost is put at about 15,000 marks. The company hopes to have these motor-cars ready in September. The omnibus tested stood the trial well.

The Disintegration of Metallic Cathodes during Electrolysis.—When a direct current is used during electrolysis and the cathodes are metallic they frequently become disintegrated or converted into dust. An interesting paper on this subject has recently been read by G. Bredig and F. Haber before the Berlin Chemical Society. If one end of a clean lead wire be introduced as cathode into a very dilute solution of a mineral acid containing a platinum anode, a black cloud of finely-divided lead dust appears round the end of the wire when high current densities are employed. The action, however, soon ceases, and the end of the wire, on examination, is found to be pitted in a remarkable fashion. Any sharp points or edges also show signs of incipient fusion. The addition of a small quantity of potassium bichromate prevents the formation of the cloud of dust. This disintegration of lead cathodes takes place with great readiness in alkaline solutions of varying concentrations. The cloud of lead dust formed is so finely-divided that it readily undergoes chemical alterations. If a solution of potassium carbonate is used as the electrolyte and a current of air and carbon dioxide led through it, white lead is obtained as the product of disintegration. One ampere-hour at 12 volts produced $\frac{1}{4}$ gramme of white lead. Chromates and bichromates prevent the action from taking place. In alkaline solutions, cathodes of mercury, tin, Rose's alloy, bismuth, thallium, arsenic and antimony, also produce clouds of the finely-divided metal. The easily fusible metals, cadmium and zinc, as well as those metals fusible with more difficulty, copper, silver, aluminium, platinum and palladium do not show the phenomenon. Besides lead, cathodes of bismuth and Rose's alloy are disintegrated in very dilute mineral acids. In alkaline solutions it appears probable that an alloy of the metal of the cathode with the alkali metal is first formed and that this is then decomposed by the water. No explanation, however, is as yet forthcoming of the disintegration of metallic cathodes in dilute acids; although the process of cathode formation of the lead in secondary batteries may possibly be connected with the formation of an alloy of the lead with hydrogen. The above is an abstract of a paper by G. Bredig and F. Haber in the *Berichte der Deutschen Chemischen Gesellschaft*, Vol. xxxi. (15), p. 2,741.

The Manacles.—With reference to the recent disasters to the *Mohegan* and the *Paris*, the Rev. W. Iago, speaking on Tuesday at a meeting of the Royal Institution of Cornwall, stated that that institution nine years ago sounded a note of warning in regard to the magnetic properties of the rocks in the Lizard district, which might have caused vessels to steer a wrong course by deflection of the compass needles. The Manacles had an affinity for the magnet equal to only one ton in 3,000 tons, but other rocks in that district were much more powerful in attraction. It remained to be seen whether the lighted and sound-producing buoy to be provided would be a sufficient warning.

The Como Exhibition.—King Humbert, on 22nd inst., opened the International Electrical Exhibition and the National Silk Industry Exhibition, organised in celebration of the Volta centenary.

How's that for High?—Give a man an inch, and he goes to—we mean takes an ell; but the fair sex for the same proportion of the foot demand an Otis elevator, judging from the following copy of a letter addressed to the Otis Elevator Company, Limited:—

> Will you send me the price and particulars of your elevators. I am going into business in a showroom, but I must be an inch taller. Hoping you (? I) can rely upon them being genuine; if so, I shall be able to give you another order for a pair. Hoping you will let me know as soon as possible, as I am wanting them this week.

The company cannot elevate her, so the lady remains *in stature quo*.

Electric Cabs.—On Wednesday the London Electrical Cab Company placed upon the London streets 80 electric cabs. Our readers will be aware of the fact that for the past few weeks these cabs have been undergoing overhauling and alteration at the company's works. On Wednesday several mishaps occurred to them, for we read that in Fleet Street one of the vehicles collided with a trap, damaging a wheel and stripping off the tyre. On Ludgate Hill one "became unmanageable," and ran into the back of a 'bus, smashing the cab splashboard and shaking the occupants. As the driver of a following cab was feeling for his colleague he smashed into the vehicle in front and damaged his own cab. A fourth collided with an Epsom coach in the neighbourhood of Farringdon Road. Three other cabs also sustained damages of various kinds. We cannot help thinking it somewhat strange that the return of the cabs to the streets should be accompanied by so lengthy a list of accidents, particularly when one bears in mind the fact that for the many months that they previously plied for hire they ran so well.

American Trusts.—The latest in trusts is mentioned in a New York telegram to the *Morning Post*. It says that one has been formed at Boston. Thirty-three electric tramway and lighting plants, all of which are in Massachusetts and Rhode Island, have combined with a capital of $24,000,000.

Life of Trolley Line Poles.—Mr. Albert B. Herrick in the *Street Railroad Journal* gives to iron poles a life of 33 years if painted every six years, and to wooden poles a life of 11 years. An iron pole fixed in concrete and painted will cost per 104 poles including the periodical painting £491. Wood poles of hard pine planed and chamfered will cost about £200, including the painting, at the end of six years. At 11 years of age they will be renewed at a cost of nearly £200, and the wiring will cost another £48, so that in 33 years the wooden poles have cost £704, or, say, £21 per annum, against £15 for iron poles for depreciation alone. There is a saving of £214 per mile in favour of the steel pole.

The Electrical Engineers (R.E.) Volunteers.—The members of the corps will parade at the head-quarters of the 1st Middlesex Engineers R.E. (Vols.) College Street, Fulham Road, on Saturday, the 27th, in drill order, leggings, bandoliers, and forage cap. Company parade at 5.45. Morris tube practice, 2 until 5. Cyclists' run to Maidenhead, June 3rd.

American Motors in this Country.—From an American technical journal we learn that the Crocker-Wheeler Electric Company are supplying 12 large motors, one of 75 H.P. for use in London in connection with various lighting and factory developments, and 10 motors for the new works of the Smelting Corporation at Ellesmere Port, near Manchester. The latter number includes two 100-H.P. motors.

NEW COMPANIES REGISTERED.

Rennie & Prosser, Limited (4,252).—This company was registered in Edinburgh on May 15th, with a capital of £5,000 in £1 shares, to carry on the business of engineers, patentees, machinists, tool makers, and manufacturers of, dealers in, and agents for cycles, and electrical and other carriages. The first subscribers (each with one share) are:—Andrew Rennie, 22, Derby Crescent, Glasgow, cycle agent; H. Prosser, 93 and 95, Mitchell Street, Glasgow, cycle agent; Claud Hamilton, 247, St. Vincent Street, Glasgow, electrical engineer; Robert Fraser and Alex. Fergusson, 232, West George Street, Glasgow, chartered accountants; K. MacGregor, 32, Renfield Street, Glasgow, insurance manager; R. Clement Boyd, 82, West Regent Street, Glasgow, writer. Table "A" mainly applies.

Automatic Electrical Advertising Syndicate, Limited (62,115).—This company was registered on May 15th, with a capital of £4,500 in £1 shares, to acquire, own, and work an invention for the display of advertisements automatically by electric power, and to adopt an agreement with Herbert A. Phillips. The first subscribers (each with one share) are:—Wm. H. Stentiford, 18, Austin Friars, E.C., secretary; P. W. Bullock, 69, Thornton Avenue, Bedford Park, W., gentleman; A. E. Hale, 47, Ranelagh Road, Paddington, W., clerk; F. Green, 19, Culford Road, Stockwell, S.W., clerk; T. S. Cowan, 18, Austin Friars, E.C., solicitor; W. E. Shawyer, 84, Earl Street, Edgware Road, N.W., clerk; P. J. Hellis, 1, Merthyr Terrace, Castlenau, Barnes, clerk. The first directors (to number not less than three nor more than five) are John Scott, Henry A. Phillips, and others to be nominated by the subscribers; qualification, £100; remuneration, one guinea each per board meeting attended.

Moser's, Limited (62,127).—This company was registered on May 16th, with a capital of £100,000 in £1 shares, to acquire the business carried on at Borough High Street and Marshalsea Road, London, as "Moser & Sons," to enter into an agreement with Robert F. Moser and Alexander S. Moser, and to carry on the business of iron, steel and hardware merchants, wholesale ironmongers, metal founders, mechanical, electrical, water, heat and motive supply engineers, sanitary and general engineers, boiler makers, millwrights, machinists, woodworkers, manufacturers of and dealers in cycles, velocipedes and carriages of all kinds, wire makers, tube makers, saddlers, galvanisers, japanners, &c. The first subscribers (each with one share) are:—Robert J. Moser, 178, Borough High Street, S.E., iron merchant; A. S. Moser, 178, Borough High Street, S.E., iron merchant; C. E. Moser, 67, Queen's Gardens, Hyde Park, W., nail merchant; Clement Moser, Lloyds, E.C., underwriter; R. Oswald Moser, 23, Maresfield Gardens, Hampstead, chemist; H. Wynn Moser, Rossarden, Riggibdale Road, Streatham, clerk; A. L. Dickenson, 19, Coleman Street, E.C., chartered accountant. The number of directors is not to be less than two nor more than five, the first are Alexander S. Moser, Charles E. Moser and Herbert Moser; qualification, £500; remuneration of Alexander S. Moser, managing director, £1,200 per annum; Charles E. Moser, £500; and Herbert Moser, £100 per annum. Registered office, 178, Borough High Street, S.E.

Passenger Communication Company, Limited (62,141).—This company was registered on May 16th, with a capital of £6,000 in £1 shares, to acquire Patent No. 14,682 of 1896 granted to Alexander Spencer for "improvements in means or apparatus adapted to be operated by railway passengers for stopping a train and attracting the attention of driver and guards," and to carry on the business of mechanical, electrical and general engineers, manufacturers and merchants. The first subscribers (each with one share) are:—W. Allen, 24, Budge Row, E.C., stationer; Henry Bishop, 16, Keming Road, East Greenwich, S.E., clerk; R. T. Glascodine, 43, Bensham Manor Road, Thornton Heath, engineer; R. Cecil Kenway, 2, Earlstoke Villas, Lansdowne Road, South Lambeth, engineer; T. T. Cowell, the Drive, Chingford, Essex, engineer; Richard A. Blackall, 45, Benbow Road, Hammersmith, clerk; G. B. Abbott, 3, Long Acre, W.C., clerk. The first directors, to number not less than two nor more than seven, are Alfred G. Spencer, Alexander Spencer, and Frank Spencer; qualification, £100; remuneration as fixed by the company.

Thomas Bell & Co., Limited (62,189).—This company was registered on May 18th, with a capital of £2,000 in £1 shares, to carry on the business of electricians, electrical and mechanical engineers, electrical apparatus manufacturers, and supplies of electricity. The first subscribers (each with one share) are:—Thomas Bell, 166, Wellington Road, Eccles, electrical engineer; George H. Uttley, merchant, and Mrs. Catherine Uttley, Halcombe, Southdowns Road, Bowdon; James W. Edgar, 96, Shrewsbury Street, Old Trafford, gentleman; H. G. Cooper, surgeon, Miss Sarah A. Uttley, and Mrs. Mary Cooper, 48, The Downs, Bowdon. Table "A" mainly applies. Registered office, Cromwell Buildings, Blackfriars Street, Manchester.

Blackpool and Garstang Electric Light Railway Company, Limited (62,150).—This company was registered on May 17th, with a capital of £10,000 in £5 shares, to apply for an order for the construction of, and to construct a light railway from Blackpool to Garstang, Lancashire, and to work the same by electrical or other power. The first subscribers are:—Thomas Fisher, J.P., Eccleston, Garstang, 20 shares; H. P. May, 5, Clifton Street, Blackpool, solicitor, 20 shares; Richard H. Mabbott, 13 and 14, Lansdowne Crescent, Blackpool, boarding house keeper, 20 shares; Mrs. Wm. Hardman, Fernleigh, Bispham, 20 shares; Richard Bibby, Moor Farm, Bispham, Poulton-le-Fylde, auctioneer, 20 shares; George Whiteside, Larbreck Hall, near Garstang, yeoman, one share; Thomas Masheter, 2, Raikes Road, Blackpool, butcher, 20 shares. Registered without articles of association.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Windermere and District Electricity Supply Company, Limited (41,461).—This company's annual return was filed on March 16th. The capital is £50,000 in £5 shares (5,000 preference). 3,000 preference and 2,237 ordinary have been taken up. 1,960 preference and 800 ordinary shares are considered as paid. £5 per share has been called on 1,040 preference, and 707 ordinary, and £2 per share on 730 ordinary. £9,195 has been paid, and £1,000 is in arrears.

Metropolitan Electric Supply Company, Limited (25,395).—This company's annual return was filed on April 14th, when 85,000 shares were taken up out of a capital of £1,000,000 in £10 shares; 2,032 shares are considered as paid; £10 per share has been called on 60,468, and £7 per share on 22,500; £762,180 has been paid.

Charing Cross and Strand Electricity Supply Company, Limited (29,122).—This company's annual return was filed on April 24th, when the whole capital of £250,000 in £5 shares was taken up and paid for in full.

Dover Electricity Supply Company, Limited (39,779).—This company's annual return was filed on April 17th, when the whole capital of £50,000 in £5 shares was taken up. £46,950 has been paid, and £3,050 is in arrears.

British Schuckert Electric Company, Limited (59,762).—This company's statutory return was filed on April 8th, when the whole capital of £200,000 in £10 shares was taken up; 10s. per share has been called and £10,000 paid.

Bute Electrical Manufacturing Company, Limited (59,371).—This company's annual return was filed on March 11th, when the whole capital of £5,000 in £1 shares was taken up; 3,400 shares are considered as paid, and 5s. per share has been called and £400 paid on the others.

British Insulated Wire Company, Limited (52,285). This company's annual return was filed on April 7th. The capital is £400,000 in £5 shares (40,000 preference) and 27,500 preference and 40,000 ordinary shares have been taken up; 5,530 preference and 29,935 ordinary shares are considered as paid, and £5 per share has been called on the others. £160,175 has been paid.

Chelsea Electricity Supply Company, Limited (20,468).—This company's annual return was filed on April 13th. The capital is £200,500, in 34,000 preference shares of £5 each, 6,000

preference of £5 each, and 500 founders' shares of £1 each; 6,666 ordinary and 500 founders' shares are considered as paid. The full amount has been called on the others, and £166,670 paid.

Northallerton Electric Light and Power Company, Limited (59,301).—This company's statutory return was filed on March 9th, when 200 shares were taken up out of a capital of £2,000 in £1 shares. No calls have been made.

Ogmore Valley Electric Light and Power Supply Company, Limited (34,191).—This company's annual return was filed on April 6th, when 710 shares were taken up out of a capital of £10,000 in £5 shares; £3,353 has been received and £197 is in arrears.

Oxford Electric Company, Limited (34,685).—This Company's annual return was filed on April 5th, when 10,000 shares were taken up out of a capital of £100,000 in £5 shares and paid for in full.

Hove Electric Lighting Company, Limited (36,942).—This company's annual return was filed on April 25th, when 10,000 shares were taken up out of a capital of £100,000 in £5 shares; £5 per share has been called on 9,000, and £1 per share on 1,000; £45,960 (including £20 in advance of calls) has been paid, and £60 is in arrears.

Anglo-Portuguese Telephone Company, Limited (24,545).—This company's annual return was filed on April 18th, when 50,000 shares were taken up out of a capital of £75,000 in £1 shares, and considered as fully paid.

Browett, Lindley & Co., Limited (32,534).—This company's annual return was filed on April 21st, when 2,762 shares were taken up out of a capital of £30,000 in £10 shares. 800 are considered as paid, and £19,620 has been received on the others.

Bournemouth and District Electric Supply Company, Limited (34,129).—This company's annual return was filed on April 12th, when 5,725 shares were taken up out of a capital of £50,000 in £5 shares, and paid for in full.

Pontypool Electric Light and Power Company, Limited (36,109).—This company's annual return was filed on March 27th, when 1,143 shares were taken up out of a capital of £10,000 in £5 shares. £5 per share has been called on 669, and £4 per share on 474, resulting in the receipt of £5,241.

City of Birmingham Tramways Company, Limited (49,548).—This company's annual return was filed on April 14th. The capital is £1,000,000 in £5 shares (80,000 preference); 60,000 ordinary and 40,000 preference shares have been taken up; £5 per share has been called on 6,047 ordinary and 40,000 preference, and £1 per share has been called on 53,953 ordinary; £284,188 has been paid, and £3 has been received on three forfeited shares.

South London Electric Supply Corporation, Limited (50,392).—This company's annual return was filed on April 10th, when the whole capital of £325,000 in £5 shares was taken up. £3 per share has been called, and £195,840 has been paid, including calls paid in advance.

British Electric Traction Company, Limited (49,855).—This company's annual return was filed on April 28th, when the whole capital of £600,000 in £10 shares was taken up. The full amount has been called, and £598,288 paid, leaving £1,712 in arrears.

Aron Electricity Meter, Limited (58,650).—This company's statutory return was filed on April 15th, when the whole capital of £250,000 in £1 shares (125,000 preference) was taken up; 125,000 ordinary are considered as paid, and 15s. per share has been called on the preference, £93,635 10s. has been paid, and £114 10s. is in arrears.

Direct Spanish Telegraph Company, Limited (6,732).—This company's annual return was filed on April 13th, when 12,931 ordinary and 6,000 preference shares were taken up out of a capital of £95,000 in £5 shares (6,000 preference). The full amount has been called, and £94,655 has been received.

House-to-House Electric Light Supply Company, Limited (25,913).—This company's annual return was filed on May 17th, when 19,661 ordinary and 12,000 preference shares were taken up out of a capital of £199,500 in £5 shares (12,000 preference); 1,000 ordinary shares are considered as paid, and £5 per share has been called and £153,305 has been paid on the others.

CITY NOTES.

Smithfield Markets Electric Supply Company, Limited.

An extraordinary general meeting was held on Friday last at Winchester House.

Mr. Browne-Martin, who presided, stated that the meeting had been called for the purpose of obtaining the sanction of the shareholders to the raising of further capital. The articles of association limited the borrowing powers of the company to £50,000, and this amount had been already issued in the shape of 4 per cent. debenture stock. It was not proposed to issue at present the whole of the £25,000 for which powers were now asked, but only such a sum as would be necessary for the extension of the company's business. The immediate object for which the money was required was to enable the board to fulfil certain contracts which had been recently obtained for lighting, and which would result in substantial profits. Further capital was also required for wiring the new meat market that was being prepared for occupation, and for the storage batteries now being laid down in the company's station. It was estimated that the saving from the latter source would not be less than £500 a year. The board proposed, with the shareholders' approval, to raise the money that was necessary on the most favourable terms. A statement of accounts had been made up to the end of April last, and this showed a profit on working of £1,180 for the seven months to that date, against a profit of £759 for the 12 months ended September 30th, 1898. The business was, therefore, gradually improving, and he might add that they were now paying the debenture interest. It was believed that the company would before the close of the present year be in a dividend-earning position. The directors propose to alter the end of the financial year from September 30th to December 31st, in order to coincide with the practice of the majority of electric lighting companies. They would, therefore, call the shareholders together in October next, in order to comply with the Companies Acts, and again early in the new year, when the accounts for the 15 months ended December 31st, 1899, would be presented. He concluded by moving a resolution authorising the directors to raise further money by the creation and issue on the best terms possible of £25,000 mortgage debentures, ranking *pari passu* as a second charge on the undertaking and property of the company next after such of the debenture stock issued by the company in the year 1898 as should for the time being be outstanding.

Mr. H. S. Leon seconded the resolution.

The Chairman, in reply to a shareholder, stated that he could not answer the question as to their company being granted powers for supplying the City. Nothing had yet been decided. It was difficult to say that there was any indisposition on the part of the City authorities to view favourably the applications of the various companies seeking enlarged powers until a decision had been arrived at. In reply to another shareholder, the chairman said that the board apprehended no difficulty in placing the new debentures. They would be offered in the first place to the shareholders of the company.

The resolution was agreed to unanimously.

The West India and Panama Telegraph Company, Limited.

The directors' report for the half-year ended December 31st, 1898, to be submitted to the general meeting on May 30th, says:—"The directors submit the accounts for the six months ended December 31st, 1898. The amount to credit of revenue is £51,937 16s. 7d. against £32,228 11s. 8d. for the corresponding half-year of 1897, and the expenses have been £24,443 15s. 6d., against £19,772 15s., leaving a balance of £27,494 1s. 1d., which, with £235 14s. 1d. brought from last account, makes a total of £27,729 15s. 2d, with which it is proposed to deal as follows:—

	£	s.	d.
First preference shares—			
Dividend, six months to December 31st, 6s. per share	10,368	18	0
Second preference shares—			
Dividend, six months to December 31st, 6s. per share	1,400	14	0
Ordinary shares—			
2s. 6d. per share (free of income-tax)	11,040	2	6
Balance to current half-year's account	4,920	0	8
	£27,729	15	2

The increase of £19,709 4s. 11d. in the total receipts chiefly arises from official and press traffic consequent on the Spanish-American war. The expenses of repairing cables during the half-year amounted to £9,037 18s. 8d, being £1,408 19s. 4d. in excess of those for the corresponding period, attributable to partial repairs to sections which were interrupted by the hurricane in September last. Some of these repairs were not completed until February; consequently the whole expense does not appear in the present accounts. The cost of the new cables laid between Grenada, St. Lucia and St. Croix, and the duplication of the Trinidad-Grenada section, amounting to £45,970 7s. 9d., has been charged to reserve fund. The directors regret to report that, owing to the unfavourable financial condition of the Leeward Islands, the Colonies of Antigua and St. Kitts have given notice that it has been found necessary to still further reduce their subsidies from £600 to £500 each per annum. In accordance with the articles of association, William Andrews, Esq, retires at this meeting, and offers himself for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, and offer themselves for re-election."

Automatic Telephone Company, Limited.

A meeting of shareholders was held on Friday last at Winchester House, for the purpose of taking the poll which, it was said, the chairman (Mr. Alexander) of the extraordinary general meeting held on the 5th inst. directed to be taken on resolutions (1) for removing Mr. Max Margowski forthwith from the office of managing director; (2) for modifying the articles in such manner as to change the

voting power of the members; and (3) for omitting from Article 96 the words "the said Max Margowski" and substituting therefor the words "the managing director for the time being."

Mr. C. G. PENNY was voted to the chair, it being stated that neither Mr. Margowski nor any of the other directors who were present wished to do so. There was a small attendance of shareholders.

Mr. W. SPYER (solicitor) in the course of a short opening statement, remarked that the directors were advised that the meeting held on the 5th inst. was irregular in every respect, but they attended it for the purpose of making a protest, and, as a safeguard, to vote against the resolutions submitted at it. On a show of hands he believed that Mr. Alexander declared the resolutions to be carried. On behalf of certain shareholders, however, a poll was demanded, which Mr. Alexander, in his capacity as chairman, appointed to be taken as on that day at noon. Curiously enough, neither Mr. Alexander nor any of the conveners of the previous meeting had put in an appearance for the purpose of taking the poll, and it seemed that they had not made any arrangements, in the way of hiring a room or otherwise, with that object. In these circumstances, he had considered it desirable that those shareholders who saw fit to attend should be given the opportunity of putting on record their votes for or against the resolutions. In doing that, he thought that he was expressing the views of all present when he said that they in no way intended to abandon their contention that the whole of the proceedings at the meeting held on 5th inst. were irregular and *ultra vires*.

Mr. J. Barker and Mr. J. W. Cohen having been appointed scrutineers, the poll was proceeded with, the result being announced as follows:—For the resolutions, *nil*; against, 117,274 votes recorded in person and 31,042 by proxy.

The CHAIRMAN then declared the resolutions lost, and added that if the other side would now agree to join with the directors and carry on the business to a satisfactory conclusion, it would be for the benefit of everybody concerned.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee (1) to appoint a special settling day in and to grant a quotation to allow the following securities to be quoted in the official list:—Callender's Cable and Construction Company, Limited—20,000 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 20,000; Electric Construction Company, Limited—further issue of £71,400 4 per cent perpetual first mortgage debenture stock. City and South London Railway Company—further issue of 5,749 5 per cent. perpetual preference shares of £10 each, fully paid, Nos. 9,252 to 15,000, and £50,000 4 per cent. perpetual debenture stock. Tuesday, May 30th, has been appointed a special settling day in Aron Electricity Meter, Limited—125,000 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 1 to 125,000; British Insulated Wire Company, Limited—29,935 vendors' ordinary shares of £5 each, fully paid, Nos. 1 to 29,625 and 39,651 to 39,960, and a further issue of 40 ordinary shares of £5 each, fully paid, Nos. 39,961 to 40,000; Hiram S. Maxim Electrical Construction, Limited—200,000 vendors' £1 shares, fully paid, Nos. 8 to 200,007.

The Birmingham Electric Supply Company, Limited.—An extraordinary general meeting of this company will be held at the offices, Dale End, Birmingham, on Thursday, June 1st, to consider and approve a Bill to be introduced in the present session into the House of Lords for the purpose of carrying into effect the terms of the sale of this company's undertaking to the Corporation of Birmingham, as stated in the agreement entered into by this company with the Corporation, dated June 10th, 1898.

Telegraph Manufacturing Company.—Subject to final audit, the directors will pay a dividend on the ordinary shares at the rate of 6 per cent., and a bonus of 2 per cent., both free of income-tax, for the period during which the shares have been paid up, being at the rate of 8 per cent. per annum, and to carry forward a balance of about £5,000, after providing for depreciation and preference dividend due April 1st, 1899, and placing £11,000 to reserve funds.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending May 20th, 1899, were £324 17s. 7d.; aggregate to date £5,047 16s. 1d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending May 19th, 1899, were £2,863 13s. 9d.; corresponding period, 1898, £2,696 13s. 9d.; increase, £167 0s. 0d.

The City and South London Railway Company.—The receipts for the week ending May 21st, 1899, were £1,079; week ending May 22nd, 1898, £987; increase, £92; total receipts for half-year, 1899, £22,358; corresponding period, 1898, £21,666; increase, £692. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending May 10th, 1899, were £160 2s. 7d.; week ending May 21st, 1898, £127 16s. 5d.; increase, £32 6s. 2d. Total receipts to date, 1899, £3,046 2s. 6d.; corresponding period, 1898, £2,345 5s. 0d.; increase, £700 17s. 6d. Miles of track open week ending May 20th, 1899, 3; week ending May 21st, 1898, 3. Car miles run week ending May 20th, 1899, 4,104; week ending May 21st, 1898, 3,305. Number of cars, week ending May 20th, 1899, 11; week ending May 21st, 1898, 7.

The Dublin United Tramways Company.—The receipts for the week ending Friday, May 19th, 1899, were as follows:—D. U. T. Co., horse cars, £1,915 19s. 10d.; ditto, electric cars, £1,064 13s.; D. S. D. Co., electric cars, £744 8s. 6d.; total, £3,724 16s. 4d.; corresponding week last year—D. U. T. Co., horse cars, £2,710 6s. 1d.; ditto, electric cars, £429 19s. 10d.; D. S. D. Co., electric cars, £556 0s. 8d.: total, £3,696 6s. 7d.; increase, £28 9s. 9d.; aggregate to date, £67,707 1s. 1d.; ditto last year, £64,440 10s. 11d.; increase to date, £3,266 10s. 2d. Worked:—The mileage open is 18 miles electrically, 26 miles by horses, as against 11 miles electrically, and 31 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending May 21st, 1899, amounted to £1,395; corresponding week last year £1,416; decrease, £21.

The South Staffordshire Tramways Company.—The receipts for week ending May 19th, 1899, were £596 2s. 3d.; aggregate receipts for 20 weeks, £12,316 12s. 3d.; week ending May 20th, 1898, £576 19s. 7d.; aggregate receipts for 20 weeks, £11,844 10s. 9d.

STOCKS AND SHARES.

Wednesday Evening.

WITH the Stock Exchange closed for three days out of the seven, it is hardly surprising that business in electrical descriptions should have moved within narrow limits. On the whole, the market has been steady, with a weak spot here and there. A fair amount of orders in Central London relieves the monotony of the Electrical Railway Market, and here a demand has arisen for the "half shares" of the company. The Preferred Half Shares, with £3 paid, are being dealt in on the basis of 3½—¾, and the Deferred Halves, £5 paid, also command a premium of about £1. There is no change to record in the price of the whole shares.

City of London Electric Lighting has, until to-night, again shown marked weakness, and it is likely that the downward course of the market is meeting with all approval from the Civic authorities. To buy up the company to-day would be a very different thing to the same operation a few months ago, when the price of Citys was over 24, or in its palmiest days last year, when 30¾ was at one time reached. The fall from the highest quotation of even this year means a considerable prospective saving to the ratepayers, and there are not wanting those who urge that the Corporation should absorb the company while the price of the shares is comparatively low. The influential buying which has taken place to-day helped to rally the price to 16½, which is ½ lower on the week. Charing Cross shares are steady, resting upon the rise that was induced by the petition which prayed the company might have power to enter the City of London, but Smithfields are unchanged, spite of the similar document drawn up in favour of this company. The remaining prices present a monotonous list of unvariableness, most of them having remained without alteration since the beginning of May. House-to-House have been sold, and close dull.

Traction shares are distinctly more lively. Most of the business transacted is in British Electric Traction, and the tendency is to sell the old shares with a view to purchasing new in their stead. For believers in the company this is a profitable transaction, since the old shares can be realised at 18¼, and the new issue are buyable at 2½ premium, £15 paid. Of course, the latter will not rank *pari passu* with the old for some time to come; but even allowing for the inequality as regards dividend and quotation, the exchange is worth making.

Telegraph Manufacturing Ordinary are 5s. better, their maiden distribution—at the rate of 8 per cent. per annum—having had a cheering effect upon the price. The announcement is what was expected by the market. For Telegraph Construction there has been a little provincial inquiry, and the price is up a point to 38½. Henleys are strong, and look like going a little better. A rise of ½ during the week has lifted the price to 25½. Callender's Cable Construction at 13 are unchanged, and the Preference are nominally 5¾—6.

A great rise of four points has taken place in the price of Eastern Telegraph stock, and we know of several holders who are bitterly lamenting the haste with which they sold their stock a fortnight ago. We consider that there is still room for an appreciation in the price, but to buy for quick profits would be folly, because the price is too wide for speculative dealing. With regard to these quotations, by the way, would it not be as well if closer prices were given, instead of the wide margins that now appear in the "official quotations?" A buyer or seller can be certain of dealing within these figures when he gives an order to his broker, but that does not alter the fact that as guides to an operator the published prices are of very slender service. It is a matter which we think calls for reform, and calls for it loudly. Eastern Extension at 16¾ are ¼ up, and there has been a buyer about of Globe Preference, which now stand at 16. Direct United States Cable are harder at 11½, and Anglo-American "B" has added the fraction at 11½.

The London Electrical Cab Company celebrated the Queen's birthday by re-starting its service in the London streets, but the market in the shares sadly wants a little galvanising. The Tramway department is marking time, and there is no special feature to record in the cheaper Electric shares.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, May 17th.	Closing Quotation, May 24th.	Business done during week ended May 24th, 1899. Highest.	Lowest.
124,400l	African Direct Telegraph, 4 % Debs.	100	...	...	...	101 —105	101 —105	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
965,560l	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	60 — 63	60 — 63	61	...
3,047,220l	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	110½—111½	111 —112	111¾	111
3,047,220l	Do. do. Deferred...	Stock	...	...	18s. %	12½— 13	12½— 13	12⅝	12⅝
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15½— 16	15½— 16	15 15/16	15⅝
75,000l	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2½— 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	185 —195	185 —195	188	...
1,332,523l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	104 —106	104 —106	106	105¼
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	...	¼— ¼	¼— ¼	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	18½— 19½	19⅜	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	9½— 10½	9½— 10½	...	...
30,000l	Do. do. 4½ % Debs., Nos. 1 to 6,000 ...	50	4½ %	4½ %	...	106 —109%	106 —109%	...	...
60,710l	Direct United States Cable	20	3 %	3¼ %	...	11 — 11½	11¼— 11⅜	11½	11⅜
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	102 —105	102 —105	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	...	160 —165	164 —169	167	162
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	100 —104	100 —104	101	...
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	101 —104	101 —104	102½	...
1,432,268l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	119 —123	119 —123	121	119
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	16¼— 16¾	16½— 17	17	16¾
16,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
64,400l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	121 —125	121 —125	...	...
35,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	100 —104	100 —104	...	...
46,500l	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	101 —104	101 —104	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	102 —105	102 —105	...	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	102—105%	102 —105%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	5⅛%	11½— 12	11¾— 12¼	12	11½
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	15½— 16	15¾— 16¼	16	15 7/8
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	31½— 32½	31½— 32½	32⅛	31¾
92,600	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	101 —104	101 —104	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	55 — 58 xd	54 — 57	55	54
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	108 —111	108 —111	...	...
490,000	National Telephone, 1 to 490,000	5	5⅓ %	6 %	6 %	4½— 5	4½— 5	4⅝	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¾— 5¼	4¾— 5¼	5	...
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —102	99 —102	99½	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1	⅞— 1	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	105 —108	105 —108	...	...
11,839	Reuter's	8	5 %	5 %	...	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	130 —135	131 —136	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4¾— 5¼	4¾— 5¼	...	...
151,733l	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000l	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	103 —106	103 —106	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph	10	1 %	8%	...	2 — 2¼	1⅞— 2⅛	2	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10¾— 11½	10¾— 11½	11¼	10¾
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	9 — 10	9 — 10	...	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	105 —108	105 —108	...	...
158,100l	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	11 — 12	11 — 12	...	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	5⅜— 6¼	5⅜— 6¼	...	...
34,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	8 — 9	8 — 9	...	...
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	114 —116	114 —116	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	16½— 17½	16 — 17	16¾	15⅞
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15 — 16	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	*nil*	11 — 12	11 — 12	11	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	14 — 15	14 — 15	14	...
17,400	Edmundsons Elec. Corp., Ord. Shares 1—17,400	5	...	5 %	...	5½— 5¾	5¼— 5¾	...	...
19,661	House-to-House Electric Light Supply, Ord., 101 to 19,661	5	...	4 %	6 %	8½— 9½	8 — 9	8⅜	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3¼— 3¾	3¼— 3¾	...	...
45,000	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 7	6½— 7	6¾	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	106 —108	106 —108	...	...
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	16½— 17½	16½— 17½	16¾	...
22,500	Do. Nos. 62,501 to 85,000‖	10	...	...	...	15½— 16½	15½— 16½	...	...
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½%	4½%	...	118 —121	118 —121	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	16½— 17½	16½— 17½	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½%	14½%	14½%	17 — 18	17 — 18	17½	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
65,000	South London Electricity Supply, Ord., £3 paid	5	...	...	...	3⅛— 3⅜	4⅛— 4⅜	3 5/16	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	14½— 15½	14½— 15½	15¼	14⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation May 17th.	Closing Quotation May 24th.	Business done during week ended May 24th, 1899. Highest.	Lowest
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	3 — 3½	3 — 3½	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	18 — 19	18 — 19	18½	18¼
10,000	Do. do. 6 % Cum. Pref. 30,001—40,000 (issued at £2 10s. prem. all pd.)	10	...	...	...	13¾— 14¼	13¾— 14¼	14⅛	14
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	126 —129	126 —129	128¾	128½
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	*nil*	*nil*	...	1⅞— 2⅛	1⅞— 2⅛	2 5/16	2¼
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	*nil*	4 %	...	2¼— 2½	2¼— 2½	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½ %	...	12¾— 13¼	12¾— 13¼	...	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	114 —117	114 —117	...	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	11 — 11½	11 — 11½	11 5/16	11⅛
178,303	Do. do. do. £8 paid	10	...	...	...	9 — 9⅛	9 — 9⅛	9⅜	9
61,033	Do. do. Pref. half-shares £3 paid ...	...	...	...	...	3¼— 3¾	3¼— 3¾	...	...
71,447	Do. do. Def. do. £5 paid ...	...	...	...	...	5⅜— 6¼	5⅜— 6¼	5 15/16	...
630,000*l*	City and South London Railway	Stock	1 9/16 %	1⅞ %	2⅛ %	68 — 70	68 — 70	69	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 £5 pd.	10	...	...	...	4⅜— 5¼	4⅜— 5¼	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3½— 4	3¾— 4¼	3⅜	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	98 — 101	98 —101	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5⅛ %	6 %	...	2 — 2½	2 — 2½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5⅛ %	6 %	...	4 — 5	4 — 5	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	96 — 98	96 — 98	...	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2⅛— 2⅜	2¼— 2½	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	⅝— ⅞	⅝— ⅞	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	...	10 — 12	10 — 12	...	...
15,000	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	24½— 25½	25 — 26	25½	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	18 — 20	18 — 20	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	112 —115	112 —115	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21½— 22½	21 — 22	21½	21¼
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	101 —105	101 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½ %	3½ %	3½ %	8⅝— 8⅞	8⅝— 8¾	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	14⅝— 14⅞	14⅝— 14⅞	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	36 — 40	37 — 41	38½	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	105 —108	105 —108	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9½— 10	9¾— 10¼	...	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5¾— 6¼	5⅝— 6¼	5⅞	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	107 —110	107 —110	108¼	107

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 10½.
British Aluminium, Ordinary, 10½—11; 7 % Pref., 12—13.
House-to-House, 4½% Debentures of £100, 105—108.
Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 107—110. Dividend, 1898, on Ordinary Shares 10%.
National Electric Free Wiring, 10s. paid, 6s.—8s.
Smithfield Market Electric, 3—4.
*T. Parker, £10 (fully paid), 16.

* From Birmingham Share List.

Bank rate of discount 3 per cent. (February 2nd, 1899).

MARKET QUOTATIONS, Wednesday, May 24th.

CHEMICALS, &c.		This week.	Last week.	Increase.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a „ Nitric	per cwt.	22/-	22/-	..
a „ Oxalic	per cwt.	32/-	32/-	..
a „ Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	87/-	87/-	..
a Ammonia, Muriate (crystal) ..	per ton	£26	£26	..
a „ „	per ton	£24	£24	..
a Bleaching powder	per ton	£5 15	£5 15	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£16 10	£16 10	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a „ (50/90 %)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£26 15	£26 15	..
a Lead, Nitrate	per ton	£23 10	£23 10	..
a „ White Sugar	per ton	£30 10	£30 10	..
a „ Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.)	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3½d.	3½d.	..
a „ Caustic (75/80 %) ..	per ton	£24	£24	..
a „ Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	68/-	68/-	..
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 15	€6 15	..
a „ Recovered	per ton	£5 15	£5 15	..
a „ Lump	per ton	£5 5	£5 5	..
a Soda, Caustic (white 70 %) ..	per ton	£7 10	£7 10	..
a „ Crystals	per ton	£3	£3	..
a „ Bichromate, casks ..	per lb.	5d.	5d.	..
METALS, &c.				
b Aluminium Wire, in ton lots ..	per ton	£224	£224	..
b „ Sheet, in ton lots..	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£65 to £137	£65 to £137	..
c Brass (rolled metal 2" to 12") basis	per lb.	8¼d.	8¼d.	..
c „ Tube (brazed)	per lb.	10½d.	10½d.	..
c „ Wire, basis	per lb.	8¼d.	8¼d.	..

METALS, &c. (*continued*).		This week.	Last week.	Increase or Decrease.
f Ebonite Rod	per lb.	3/-	3/-	..
f „ Sheet	per lb.	5/-	5/-	..
g Copper Bars	per ton	£80	£80	..
g „ Wire (basis price) ..	per lb.	10½d.	10½d.	..
g „ Sheet	per ton	£80	£80	..
g „ Rod	per ton	£80	£80	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha, fine	per lb.	6/-	6/-	..
h India-rubber, Para fine ..	per lb.	4/1½	4/1½	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i „ Pig (Cleveland warrants)	per ton	55/11	55/5½	5½d. inc.
i „ Forgings, according to size	per ton	From £11	From £11	..
i „ Scrap, heavy	per ton	50/- to 55/-	50/- to 55/-	..
i „ Wire galvanised No. 8 ..	per ton	£10 2 6	£10 2 6	..
g Lead, English Ingot	per ton	£14 12 6	£14 12 6	..
g „ „ Sheet	per ton	£15 7 6	£15 10	2/6 dec.
l Mica (uncut slabs 8" long) ..	per lb.	6 8	6 8	..
m Manganin Wire No. 28.. ..	per lb.	8/-	8/-	..
g Mercury	per bottle	£8 5	£8 5	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p „ r'l'd strip & sheet	per lb.	From 1/2½	From 1/2½	..
o Platinum	per oz.	£3 10	£3 10	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n	p. ton	From £15	to £40	..
i Steel, Magnet, in bars		£58	£58	..
g Tin, block	per ton	£115	£115	..
g „ foil	per lb.	1/6	1/6	..
n „ wire Nos. 1 to 16	per lb.	1/7	1/7	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£40 to £65	£40 to £65	..
j Yarns, Cotton, Single 10lb. bundles	pr lb.	7½d.	7½d.	..
j „ Best Flax, 6 lea. ..	per lb.	4½d.	4½d.	..
j „ Hemp, 3 ply 10 lbs. ..	per lb.	8½d.	8½d.	..
j „ „ Russian, 10 lbs.	per lb.	4½d.	4½d.	..
j „ Jute, 180 lbs. rove ..	per ton	£12	£12	..
j „ Manila, 24 thread ..	per ton	£32 10	£32 10	..
k Zinc, Sheet (Vielle Montagne bnd.)	p.t.	£31 10	£31 10	..

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakespeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yeo & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
l Messrs. Sanders, Wake & Co.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

SINGLE LINE BLOCK SIGNALLING.

In a recent article on "Signalling on Single Line Railways" we described a set of apparatus designed by Mr. Hollins for working intermediate stations. We now illustrate the Sykes system, which is being manufactured under license by Messrs. McKenzie & Holland, of Worcester, who have devoted themselves to the development of this particular form of single-line working. From the figure it will be seen that B and C are stations without loop lines or sidings, merely block stations for the relief of heavy traffic, and can be switched out at any time when necessary. The starting signal levers in the signal cabin are in their normal condition, "locked at danger," and are only released electrically from the station or section *to* which the train is being despatched. The plungers of the electric instruments, P P I, P P I, at B and C, are respectively released by the home signal levers, 4, 7, 8, and 11, and the plungers, X and Y, at A and B are released by the draw handles, H^1 and H^2. The following notes are descriptive of the working of the system:—

Assuming a train at A is to be despatched to B and of course on to D. The signalman at A calls upon B on the bell, to which B replies also by bell. B then pulls over his up home signal lever 4 thereby releasing his plunger, P.

The object of first pulling over the home signal lever 4 is to mechanically lock the home signal lever 7 in the opposite direction. This lever cannot now be returned to its normal position until the train from A arrives and passes over the treadle, Z. It can, however, be put back sufficiently to allow the arm of the home signal to be thrown to "danger" in cases of emergency, but not the full travel to release conflicting levers. The plunger, P, being now released is pressed—the words "train accepted" appears in the lower opening of his instrument—and a current is sent to A which takes the lock off starting signal lever 2. A now pulls this lever over and lowers his starting signal—the lever becomes electrically locked in the "over" position and cannot be returned to the normal until the train has passed on out of the section over the treadle Z at B; though the arm 2 can be put to "danger" if necessary, the same as with the home signal. The lever 2 is mechanically interlocked with the draw handle, H, therefore when 2 is over H is locked in the normal, and the plunger, X, being released by H cannot be used by A to give "line clear" to B. As B has pulled his home signal lever 4 over, and plunged to accept a train from A, his starting signal lever 5 is doubly locked, by the electric lock from A, and the mechanical interlocking between it and 4. The plungers when once used to send a releasing current respectively become locked, and cannot be used again until the train arrives and passes over the releasing treadle. The train on leaving A passes over the treadle W and puts the starting signal 2 automatically to "Danger" behind it, and A is powerless to lower it again to send a following train until the first one has passed out of the section, and 2 has again been released from B. The train on arriving at B and passing over the treadle Z takes the forward locks off both the starting signal lever 2 at A and the home signal 4 at B; these signal levers can now be returned to their normal positions, and the line will then be free for a following train. To send the train on to D similar operations are gone through referring to sections B, C and C, D, as in the case of A, B. When stations B and C are switched out the locking and working is precisely the same between A and D as between A and B. At station D trains may, with perfect safety, be accepted from A and E at the same time, the lowering of the home signals 14 or 15 being quite optional.

With regard to shunting operations, these can be carried on with perfect freedom directly a train has *departed* from a station.

A perfectly safe arrangement for cancelling signals sent in error has been provided, by which both signalmen at A and D must concur, or the cancelling cannot be accomplished.

Intermediate sidings can be safely provided for, in cases of goods trains from A picking up waggons and going on to D, or where the train is going from A to pick up, and return to A.

The train in all cases has the entire control of the section upon which it is either running or standing, and no other train can be again signalled on to that section until the first has passed out of it.

The provision that is made when B accepts a train from A to prevent C accepting a train at the same time from D, is as follows:—The home signals 4 and 11 at each station respectively release the plungers, P and P', for trains in opposite directions. By a very simple device, No. 4 at B when pulled over electrically locks No. 11 at C', and *vice versâ*. B, having pulled 4 to accept from A, locks 11 at C', and thus prevents him accepting from D.

The advantages claimed for this arrangement over the staff, tablet, or similar systems, are as follow:—

1. Simplicity to drivers is not having two indications of safety to lock out for, *i.e.*, the staff and the starting signal. The signal is now the one and only thing that he requires. Numberless cases can be given where the driver has gone away and forgotten the staff or tablet, or carried it on into the next section.

2. Saving of time over the troublesome method of first having to return the staff or tablet into the instrument before getting out another one with which to send a return train. This invariably involves running round a train standing at the platform, crossing the line to the station master's office, exchanging the staff, and returning to the engine driver, thereby causing considerable delay.

With this appliance, as *soon as a train has arrived* at A from D, A is free to send a train back to D *at once*. Provided there are no trains following in the immediate sections.

3. No necessity to slacken speed of trains to pick up staff or tablet when running through non-stopping stations.

4. A station can be switched out, and trains run through as though it did not exist.

5. No accumulation of staffs or tablets at one end of a section owing to unequal traffic.

THE TELEPHONE SERVICE.

The following is a copy of the Treasury Minute, dated May 8th, 1899, upon the proposals for the development of the telephone system in the United Kingdom:—

1. My Lords have before them the Treasury Minute of May 23rd, 1892, the several agreements made between the Postmaster-General and the National Telephone Company, and the report of the Select Committee of the House of Commons appointed last session to consider the condition of the telephone service.

2. The Committee find—

(i) that the existing exchange service is not of general benefit to the country, and that it is not likely to become of general benefit so long as the present practical monopoly in the hands of a private company shall continue;

(ii) that competition by either the Post Office or the local authority is necessary in the public interest, and that the Post Office is not prevented either by legal agreement or by good faith from competing in any areas either by itself or by means of licenses.

3. My Lords agree generally in this conclusion and approve of the proposals of the Postmaster-General—(i) that licenses should be granted to certain local authorities to transact telephone business within appropriate areas; and (ii) that the Post Office should itself open telephone exchanges in London, as soon as Parliament has provided the necessary funds.

4. Local authorities cannot, without the sanction of Parliament, borrow on the security of their rates or use their funds to establish a telephone service. My Lords are of opinion that this sanction may be most conveniently given by a general Enabling Act, and a Bill containing the necessary provision on the subject has been introduced.

5. The licenses to local authorities will be of the same general character as that held by the National Telephone Company and will contain a provision that the local authorities licensed by the Postmaster-General shall connect their exchanges with post offices in order that persons using their telephones may, on payment of the usual charges,

(*a*) speak over the trunk lines of the Postmaster-General;

(*b*) speak messages to a post office for delivery as telegrams, express letters or ordinary letters; and

(*c*) call for the services of express messengers.

My Lords propose that messages which are to be delivered as express letters should be spoken for that purpose, not only as at present to a post office in the same town, but to any post office connected with an exchange. Thus, any person using a call office will be able to secure the delivery of his message in any part of the country where an exchange is established.

6. In order to ensure that telephonic communication shall be open as far as possible to persons who do not rent a telephone, the Postmaster-General will require licensed local authorities to open call offices at post offices, and will confine the charges at such offices within reasonable limits; while the restriction hitherto imposed upon renters of telephones, that they shall not allow their telephones to be used by persons outside their own households, will be removed in all cases where messages are paid for on the "toll" system, whether the telephones are rented from the local authority or from the National Telephone Company. Thus it is anticipated that some classes of subscribers will be ready to offer to the public the use of their telephones either gratuitously or for a small fee.

7. It will be a condition of the licenses granted to local authorities that no terminal charge shall be levied by the licensee upon trunk-wire messages originating in an exchange of the Post Office, or of any other local authority, or of the National Telephone Company, if (in the latter case) the Company cease to levy such charges on trunk-wire messages originating in the exchange of the local authority.

8. The following conditions will also be attached to a license to a local authority:—

(*a.*) That the plant shall be of such character and so constructed as the Postmaster-General may from time to time direct or approve.

(*b.*) That there shall be no preferential treatment as between one subscriber and another.

(*c.*) That the system of charge and the maximum and minimum sums to be charged shall be subject to the Postmaster-General's

approval and (if necessary) revision; and that yearly accounts shall be submitted to him of the revenue and expenditure of the service.

(*d.*) That neither the license nor any of the powers conferred by it shall be assigned or sub-let, and that no plant shall be sold to, and no working agreement made with, another licensee without the sanction of the Postmaster-General.

(*e*) That the license shall be subject to determination if the local authority does not *bonâ fide* establish a telephone exchange system within a reasonable time and maintain such system in effective working.

9. The royalties payable to the State will be the same as those specified in the National Telephone Company's license.

10. All licenses will be terminable on December 31st, 1911.

11. With respect to the purchase of plant whether of the local authority or of the Company, my Lords agree with the conclusion of the Select Committee "that the Postmaster-General should in no case undertake to buy useless or antiquated plant." Single wire circuits, for example, fall into this category. Subject to this consideration, it will be a condition of the license to a local authority, that on the termination by the Postmaster-General of such license the local authority shall sell, and the Postmaster-General shall purchase, all plant then in use in the telephone service of the local authority which is suitable for the actual requirements at the time of the local service of the Post Office. The question of suitability will be left, if the parties differ, to the decision of an arbitrator, subject to the provision that no plant shall in any case be considered suitable which has been brought into use without the sanction of the Postmaster-General. The plant will be taken at its fair market value at the time of the purchase without any addition in respect of compulsory purchase or goodwill or profits, the value to be ascertained by arbitration if necessary.

12. My Lords propose that where, within a reasonable period, *bonâ fide* competition between the National Telephone Company and any local authority is established in any area where the Company are now working, similar treatment should be applied to so much of the plant of the Company in such area as existed at the time when the competition was inaugurated. Further, if the Company within a reasonable period give intercommunication in such area between their exchanges and the exchanges of the local authority, on conditions approved by the Postmaster-General, the purchase will extend (on the same terms) to the plant of the Company constructed (with the sanction of the Postmaster-General) after the commencement of the competition.

13. The Postmaster-General will consider all applications for licenses by local authorities with reference to the circumstances of each case, and will exercise a discretion both as to the grant of the license and as to any modification of its terms (not inconsistent with the principles indicated in this Minute) which he may think desirable.

14. The right of the Post Office to establish telephone exchanges, and to license persons, companies and other bodies, to establish such exchanges—a right explicitly reserved in every license and agreement with the National Telephone Company—will remain intact; and should Her Majesty's Government at any time see fit to exercise this right in a manner different from that indicated in this Minute, neither the Company nor any local authority will have any ground to complain of breach of contract or want of good faith on the part of the Postmaster-General.

My Lords concur.

Let a copy of this Minute be laid before Parliament.

SOME EXPERIMENTS WITH THE CALDWELL INTERRUPTERS.*

By CHARLES T. CHILD.

A number of experiments were undertaken, using the apparatus described by Mr. E. W. Caldwell in the last number of the *Electrical Review*, to determine the nature of the phenomena exhibited, and, if possible, to form a basis for some theory of the action of the apparatus.

The interrupter consisted of a glass jar having a central lead electrode, and covered with a varnished wooden top, through which a number of test tubes projected into the liquid electrolyte. Each of these tubes was punctured with one or more holes, ranging in size from $\frac{1}{64}$ to $\frac{1}{8}$-inch, and one of them was provided with a sort of nipple of glass tubing, about $\frac{1}{16}$-inch core and $\frac{1}{4}$-inch long.

A battery of 10 accumulators, connected directly through the instrument, fig. 1, gave negative results. In certain tubes there was observed an occasional bubble, accompanied by a clicking noise. Upon the introduction of a variable inductance in the circuit, fig. 2, it was found that, at a certain point, the clicks became sharper, and that when a little more inductance was included the apparatus suddenly began to interrupt. The addition of inductance *increased* the frequency, this rule holding through the limited range of inductance available. It would be very interesting to discover how the frequency varies with the self-induction of the circuit through a large range, and also to note the effect of a variable capacity upon it.

* New York *Electrical Review*

With increased electromotive force the frequency rises, both the pitch and loudness of the tone emitted by the interrupter rising.

If the interrupter is paralleled with a high resistance shunt, such as an incandescent lamp (fig. 3), two effects are noticeable:—The frequency is diminished, the action of the interrupter becomes less violent, and the lighting of the lamp shows the existence of a high electromotive force around the interrupter. Using the primary of a large induction coil as the inductance, and a current of about 6 or 7 amperes at 110 volts, the electromotive force developed across the

Fig. 1.

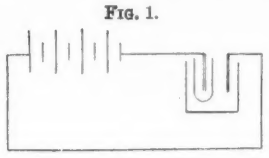
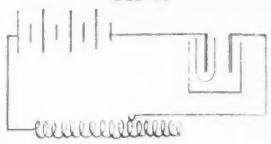


Fig 2.



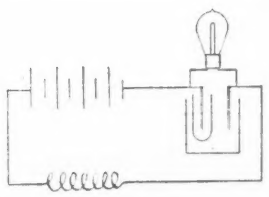


Fig. 3.

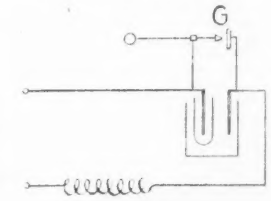


Fig. 4.

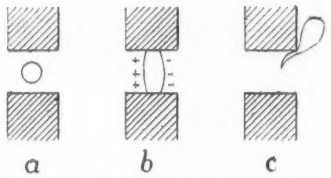
interrupter was, judging from its action on lamps, &c., probably more than 1,000 volts. Incandescent lamps were blown to pieces by it with a sharp report. The arrangement shown in fig. 4, in which a spark gap, G, was shunted around the interrupter, was also tried, the striking distance, under the conditions described above, being about $\frac{1}{16}$ of an inch.

During the operation of the instrument the orifice in the test tube is filled with a pink blaze, and streams of small bubbles are violently projected from it. This is true even if the hole in the tube is at the bottom, as shown at *a* in fig. 5. With this tube the bubbles are shot down 2 or 3 inches into the liquid.

The effect of the instrument upon an induction coil is quite different from that produced by Wehnelt's interrupter. When the latter is used the secondary discharge seems to be almost purely alternating, a roaring arc playing across the terminals. With Caldwell's interrupter the discharge seems to be undirectional, a shower of blue sparks of great energy being maintained by the secondary.

It is, perhaps, premature to advance any theory for this interrupter, but an observation of its working leads almost irresistibly to the conclusion that the phenomena exhibited are only in part due to thermal effects. It can be imagined that some such action, as is shown diagrammatically in fig. 6, takes place. Here the sketches represent

Fig. 6.



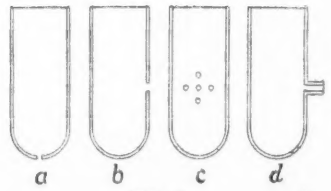


Fig. 5.

cross-sections of the orifice in the glass tube. At A a bubble is forming, in the middle of the cylindrical filament of liquid connecting the two sides of the apparatus. The middle section of this fluid cylinder, not being cooled by conduction so rapidly as the surface in contact with the glass, is rapidly brought up to the boiling point. Of course, the formation of the bubble in the already hot liquid narrows its cross-section and accelerates the complete separation of the thread of liquid, as at B. But when the separation is accomplished, the inductance of the circuit causes an accumulation of potential, the value of which is determined by a number of causes, at the faces of the separated liquid. There is thus established an electrostatic pressure tending to reunite the liquid thread, and this may be very great if the separation is small and the potential difference of the order of thousands of volts. Hence the liquid is violently reunited, squeezing the bubble out of the orifice, somewhat as shown at *c*, and all is ready for the next cycle.

This roughly tentative theory is suggested simply as worthy of consideration until further and accurate experiment shall show more clearly the principle underlying the extremely interesting phenomena presented by this apparatus.

MAGNETISM.*

By Prof. JAMES ALFRED EWING, F.R.S., M.I.C.E.

(*Continued from page* 832.)

The dynamo machine underwent a course of improvement which was, in part, the necessary consequence of its design being seriously taken up by mechanical engineers, but in great part also the result of magnetic research. To no man did it owe more than to one who was lately taken from us in the fulness of his powers and in circumstances of peculiar sadness. John Hopkinson's contributions to the development of the modern dynamo were many, but I would specially refer here to his part in establishing the theory of the magnetic circuit. Though the idea of the magnetic circuit had been more or less vaguely present, mainly by analogy, in the minds of other thinkers, it was for the first time explicitly formulated in a way to command assent in a paper by the brothers John and Edward Hopkinson, and was further applied by them with remarkable effect to problems of dynamo design. A right appreciation of the principle of the magnetic circuit has been one powerful factor in the evolution of the modern dynamo. Another has been the advance which has taken place, through experimental research, in our knowledge of the magnetic qualities of iron. I shall endeavour, before we have done, to pass in rapid review some of the principal facts in magnetism with which the dynamo builder is concerned.

Imagine a conductor wound into a coil which carries an electric current. Each of the lines of force, or as we will rather call them for the present purpose, lines of magnetic induction due to the current, passes through the interior of the coil, and returns into itself through external space. The path taken by these lines constitutes the magnetic circuit; it is interlocked with the circuit of the conductor, and in this instance it fills all space, for the lines returning outside the coil are spread without limit. Imagine next that the coil is a long helix, and that it is bent round to form an endless ring. The lines of induction are now confined to the interior of the ring; they still form a closed circuit interlocked with the circuit of the conductor, but they now close themselves without spreading into outside space. If we strengthen the current in the coil we strengthen the induction in the magnetic circuit. If we fill the space within the coil full of one substance or another, we find in general very trifling variations in the induction within. But if one of the three metals, iron, nickel or cobalt, be placed as a core within the coil, especially if the one chosen be soft iron, we find an enormous difference. The induction within the coil is then many times greater—it may even be thousands of times greater—than it was before the iron was put in. This familiar fact is expressed by saying that iron, and, in a lesser degree, nickel and cobalt, possess exceptional permeability to magnetic induction.

A core of iron, however strongly magnetised, would be of no service in a dynamo unless we imagine a gap to be cut in it, where the conductor, whose movement across the lines of induction is to produce current, can be placed. The practical function of the field magnets is simply to produce a strong induction in the narrow gap where the armature coils revolve. The business of the fixed coils, to which the magnetisation is due, is to establish a mixed magnetic circuit, forcing the magnetic induction not only through the iron, but across the much less permeable gap Hopkinson's discussion of the magnetic circuit showed how it might be arranged in the way most favourable to efficiency, and how, knowing the dimensions of the system and the magnetic quality of the iron, we could predicate what amount of magnetic induction would be set up in the gap by a given current in the field magnet's coils, and hence predetermine the behaviour of the machine.

No sooner was the dynamo introduced than it was discovered that its function could be reversed. Given a supply of electric current, the dynamo, acting as a motor, would serve to convert the energy of the current into mechanical work. This opened up an immense additional field for the industrial uses of magnetism. I need not take up time by referring to matters of everyday observation. No one does not know how the dynamo, acting both as generator and as motor, has given us a new branch of engineering of so vigorous growth, that it almost threatens to eclipse the parent stem. It has given us electric lighting and the electric distribution of power. It has taught us to harness Niagara, where I was glad to see that the engineers have still left some water, and other waterfalls, where I am sorry to think they have left none. It has created new metallurgical processes and new chemical manufactures with the aid of the electric furnace and the electrolytic vat. It has given us electric railways and tramways, or, rather, it has given them to our neighbours on the Continent and our friends over the sea, for you will find more electric traction in a single American or Canadian city than in the whole of Great Britain.

Faraday's further discovery that the induction of magnetism in an iron core by setting up a current in a surrounding coil would induce a current in a second coil wound upon the same core was the parent of the induction coil and the transformer. Alternating currents in the primary circuit produce reversals of magnetism in the core, and thereby induce corresponding alternating currents in the secondary circuit, the ratio of electric pressure between the two depending on the number of turns in the winding of the two coils. It is to the induction coil that we owe the high-pressure currents required for Herizian telegraphy, and for the Röntgen rays. The transformer—an induction coil with a core closed upon itself to form a complete magnetic circuit in iron—gives the engineer means of economically conveying electric energy over long distances, by first raising it to a pressure which may be transmitted with but little loss in a long conducting wire of moderate size, and then lowering it to a pressure at which it may be utilised without inconvenience or danger. The principle found its earliest engineering embodiment in the crudely designed "secondary generators" of Gaulard and Gibbs. Here we have another notable application of magnetism, and it may be added that it is by applying magnetic theory and magnetic experiment that the conditions are practically arrived at which allow the conversion of electricity by the transformer to be performed efficiently. Here, too, a study of the magnetic qualities of iron is all-important to the electrical engineer.

A few incidental applications of magnetism to engineering purposes remain to be briefly mentioned. The attraction across a surface of division between two parts of a magnetic circuit, originally investigated by Joule in 1838, is made use of in the workshops in a variety of ways. Magnetic crane hooks are employed to lay hold of and lift heavy plates. Drills and other tools are attached by magnetic attraction to the piece on which they are to work. Magnetic clutches serve to connect and disconnect lines of shafting. Magnetic brakes have been applied to the wheels of vehicles. In all these cases the force which is taken advantage of is due to magnetisation; it comes and goes with the making and breaking of the magnetising current, and it may readily be made to amount to nearly 200 lbs. per square inch.

Thermo-magnetic engines have been devised to perform directly the conversion of heat into work. A piece of iron heated to bright redness (say 780° C.) loses nearly all its capacity for magnetic induction, and ceases to be attracted by a magnet. It may therefore be withdrawn from the neighbourhood of a magnet pole without expenditure of work; but once the iron is cooled, the magnet resumes its attraction. Hence by heating the iron when it is in a strong field, then removing it while hot to a place where the field is weaker, then cooling it till the magnetic action re-asserts itself, and then allowing it to return, we take it through a cycle in which mechanical work is done by it, work which may be applied to a useful purpose by appropriate means. The energy to do the work comes from heat, more heat being absorbed in the heating of the iron than is given out in the cooling. But though it is easy to make a working model which will illustrate the principle of this action, the task of making an engine which will carry it out efficiently on a practical scale has not been accomplished, nor is it in the least likely of accomplishment. A model is shown on the table in which the working substance is nickel, which loses its magnetic quality at a lower temperature than does iron, and by alternately heating and cooling the piece as it swings in pendulum fashion towards and from the pole of a magnet, enough heat is converted into work to keep up the swing.

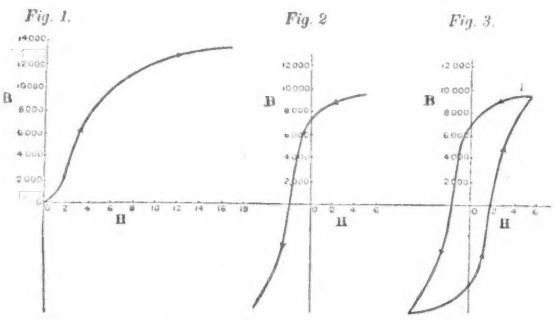
Yet another application of magnetism, and one with a more promising future, is the use of the magnetic field in separating magnetic from non-magnetic substances. A familiar instance is the workshop process of separating iron filings and turnings from brass. Edison has lately turned this idea to practical account by employing magnets in the concentration of iron ore. One of the most widely diffused ores of iron is the magnetic oxide—the material of the loadstone—which is susceptible to magnetic induction, and is therefore attracted by the magnet. In most cases it is so much intermixed with foreign matter that, to smelt the mixture, would not be remunerative. Edison's process renders it possible to work such low grade ore economically. He first grinds it, and for the operation of grinding he has devised machinery remarkable for its boldness in conception and its ingenuity in detail. He then causes the ground mass to fall in a stream before the face of a magnet which deflects the particles that are capable of attraction; so that, while the earthy matter continues to fall vertically, the concentrated ore falls to one side, and is separated out. In practice the crushing and magnetic separation proceed in a long series of stages. Through this process of concentrating low grade iron core by magnetic winnowing, as one may call it, Edison hopes, and apparently not without reason, to unlock vast natural stores of iron which have hitherto been unavailable, and he has shown the courage of his convictions by spending great sums on the plant by which the process is now being tested on a commercial scale. His crushing and separating machinery at the town of Edison, New Jersey, is able to deal with 5,000 tons of ore a day, and it is said to produce a concentrate containing 67 per cent. of iron from crude ore containing only 20 per cent. An English syndicate has taken up this matter, and though the prospectus is not yet brought to the birth, the prospector is already at work searching in the Scottish highlands for beds of mixed magnetic ore. In this search he is guided in the first place by the magnetic survey of Rücker and Thorpe, expecting, *primâ facie*, to find deposits of ore where they have detected local perturbations of the terrestrial magnetic field. Here we have an example of what occurs over and over again in the history of scientific discovery. A utilitarian application unexpectedly follows a piece of scientific research which at the time it was made seemed to have none but the most abstract interest. In the evolution of engineering few things are more conspicuous than the ultimate usefulness of "useless" knowledge.

The electrical engineer requires special iron to derive the best results in his dynamos and transformers, and the supply of it has become an important industry. The carbon and manganese which are essential in steel that is intended to be strong, are prejudicial in steel that is intended to be magnetic. Special steel castings, consisting of almost pure iron, now supply the dynamo builder with a material that is excellent in magnetic quality, and, being cast, they are readily supplied in appropriate shapes for the field magnets. Special iron and steel is rolled into sheets and stamped into the forms which are wanted for the armatures of dynamos and the cores of transformers, and the magnetic quality which it possesses is immensely superior to that of any iron which could be obtained a few years ago. The testing of iron for magnetic quality, which, within my own experience, was a matter of original research, is now an everyday operation in the

* Institution of Civil Engineers, James Forrest lecture.

workshop, and iron is ordered to specification of its magnetic properties, just as in other departments of engineering it is ordered to specification of its strength.

In the magnetisation of iron we are concerned mainly with two properties. One is permeability, or the readiness with which the metal takes up magnetic induction, the other is a property to which some 18 years ago I gave the name of "hysteresis," after an investigation that was undertaken without any idea that the property in question would come to be commercially important. To understand what happens when iron is magnetised, consider again a ring of iron forming the core on which a magnetising coil is wound. A current passing through the coil subjects the ring to magnetising force, which increases in simple proportion as the current is increased. But the magnetic induction within the core does not increase proportionately to the magnetising force. Let the magnetising force be



MAGNETISATION OF IRON.

gradually raised. At first the increase of induction is slow, then very rapid, then slow again. You observe three more or less clearly marked stages in the process (fig. 1), and in the special cases you may see the three very sharply distinguished from one another, as in fig. 4, which exhibits the magnetisation of a piece of nickel under certain conditions as to stress. Thus the permeability of iron is a variable quantity, comparatively small for small magnetising forces, very large forces of medium intensity, and then compuratively small again when the force is strong. In all three stages, however, the induction increases faster than the magnetising force increases. But by using

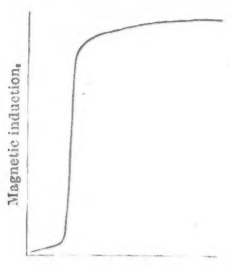


FIG. 4.

AGNETISATION OF NICKEL IN A STATE OF TORSION (NAGASAKA).

exceedingly strong forces, we find that a fourth stage is reached, in which the increase of induction is only equal to the increase of magnetising force. When that happens the iron is said to be saturated. After that it has no greater power of taking additional induction than a piece of brass or wood. Engineers have nothing to do with that extreme condition of magnetisation. In the transformer and the dynamo we are concerned only with what I have here called the second and third stages of the process.

Next, suppose that after the magnetising force, H, has been raised to any value, it is reduced, say, to zero, fig. 2. We find that the magnetic induction, B, also becomes reduced, but by no means so much as you might expect. It tends, in great measure, to persist, and a good part of it survives the complete withdrawal of the magnetising force. Let the process be continued by applying magnetising force in the opposite direction to the first, and then let the force be again removed and reversed. We thereby get the cyclic process of change illustrated in fig. 3. Throughout this process the changes of induction lag behind the changes of magnetising force, and it is this lagging behind that is called hysteresis.

Residual magnetisation is one of the consequences of hysteresis, and when steel is wanted for permanent magnets the maker has to aim at getting as much hysteresis as possible, which he generally does by putting in some tungsten. But in most of the magnetic uses of iron it is desirable to reduce hysteresis to the uttermost. This is notably true of dynamo armatures and the cores of transformers. In the core of a transformer the magnetism goes through repeated cycles of reversal, such as the cycle shown in fig. 3, often as frequently as 100 times a second. Now every such cycle means an expenditure of energy, which is greater the greater the hysteresis. It is easy to prove (as was first done by Warburg) that the area enclosed by the two curves which make up the cyclic process is a measure of the work that is spent upon the iron. That work is wasted; it is simply dissipated as heat. The efficiency of a transformer consequently depends on this, more than on anything else, whether the core is made of iron having little hysteresis. Various specimens of iron differ very widely in hysteresis as well as in permeability, and hence the practical importance of magnetic tests.

(To be continued.)

MACHINE SHOP MANAGEMENT IN EUROPE AND AMERICA.

CONTINUING his articles in the *Engineering Magazine*, Mr. H. F. L. Orcutt contrasts the workmen of Europe and America especially in regard to what he terms the pigheadedness of the trade unions. Hence arises the fact that the workers are a mere inert block to progress, whereas in America they are aids to progress. Making allowance for his natural bias this may be taken as correct, though we observe from American papers that there is a great tendency in America as here to rob a man of anything he may suggest in the shape of improvement. American manufacturers are thus brought to demand more from tool makers than is asked from European tool makers, and this has produced the automatic tool. Mr. Orcutt also accuses European manufacturers of buying old-fashioned tools purely out of sentiment and old business connections, and he considers that Government orders have a stagnating influence. Government shops are old and slow and their influence permeates to private works which receive Government orders. His residence in Germany does not appear to have imbued him with any idea of Germany's power to compete with England. He cannot trace the origin of the idea. He does not even consider Germans are better educated than Englishmen—differently it may be as in languages, but not on the whole better. The German clerk idea he regards as overdone, and cites a case where a man employs German juniors, but Englishmen only for responsible posts. His conclusion is that England in mechanical matters has nothing to fear from Germany if only she will renovate her workshops. Her social institutions are better, her resources equal and her workpeople more efficient, but he applauds German capitalistic enterprise. America, however, he holds to outrival us in all except foreign trade, for we are behind America in natural resources and in the efficiency of workmen—this last, however, not perhaps incurable. He anticipates a big future for American products, but having lived in England he has acquired what all Americans do acquire after any residence here, a profound contempt for the policy of his own countrymen. They have no understanding, they are humbugged by stay-at-home politicians who are under the delusion of nursing "infant industries." He deplores the policy which prevents trade and calls loudly for free trade. To find an American, in an American magazine, calling for free trade without being howled down as a recipient of British gold from the Cobden Club by every American paper is indeed a change. Similarly he condemns the German Agrarian Party as swindling the workmen of Germany out of the very food necessary to enable them to work, and he remarks that the main food of all workers, bread, is cheaper in England than in any other country. Mr. Orcutt is not sparing in his use of forcible terms wherewith to make his meaning plain, and he makes out a good case for American manufacturers, especially in respect of the ease and celerity with which they can deliver goods in England, as well as the cheapness. He condemns the State railway management in France and Germany as cumbersome, and very difficult to move, and this, with other considerations, is helping America in spite of her 3,000 miles distance, which, however, has been practically overcome by steam, and cannot even be set down to-day as an adverse factor, for do we not hear of goods sent from Glasgow to London, *vid* New York, being transhipped in New York Harbour.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

"MISCELLANEOUS NOTES ON THE CHELTENHAM MAINS." By Mr. HAMILTON KILGOUR, Member. Read April 25th, 1899.

(*Concluded from page* 836.)

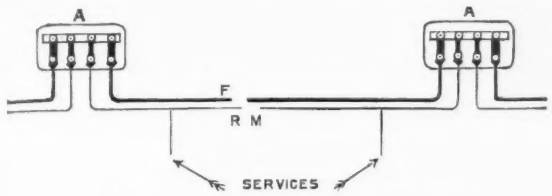
THE larger transformers are dried in a somewhat similar way, except that they are usually dealt with individually and have their secondaries connected through resistances to a low pressure circuit and their primaries to lamp loads. In sub-stations we usually, and in very dry ones invariably, run these transformers with their top covers loose; this we find a satisfactory plan.

The desire that the occurrence of a fault, or the connection of a new customer, should disturb as little as possible supply to existing customers has resulted—as will have been clear from the foregoing brief account of our mains—in an extensive sectionising of both the high and low pressure mains. It will also be obvious that this dividing of the mains into comparatively short sections immediately localises a fault to within a small distance, and reduces the work of

finding its precise position to merely—in general—testing a single length of cable.

I think that there is one point in connection with the finding of faults which deserves more attention than has been usually given it, and I consider that to localise the responsibility for the fault is almost as important as to localise its position.

Faults on our mains have been due in several cases to external damage, in a good many to defects in manufacture, in two or three to water getting into boxes with oil insulation, and in one case to a

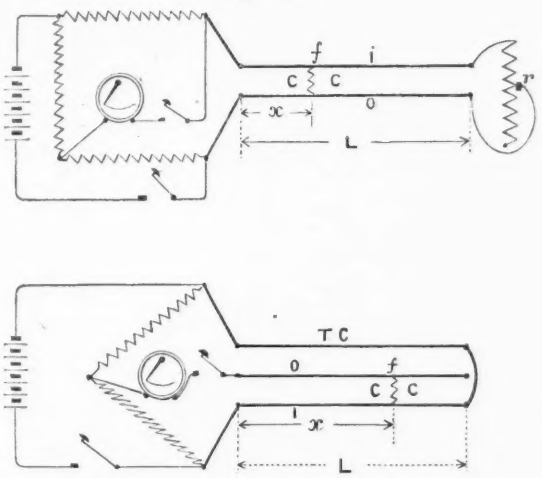


A A, 4-way joint boxes; F, Feeder; R M, Riding main.

DIAGRAM SHOWING FEEDER AND RIDING MAIN.

badly made joint. I think it fair to add that most of the faults due to defects in manufacture occurred on a 200 yard length of cable, which was not made by Callender's Cable Company, and which I tried for high pressure services to house transformers. Cases of external damage done to cable are now happily rare, since all road openings, for whatever purpose, are now made by either the highways or the waterworks department of the Corporation, who give us, as a rule, adequate notice to enable us to send a man to look after our work where necessary. Up till a few months ago, however, any building contractor or plumber would make road openings at his discretion, without giving the notice required by our bye-laws, at any rate till it was too late to send a man to supervise the work on our behalf, and the result of this was a number of faults.

LOOP TEST.



C C, Concentric cable; I, Inner; O, Outer; T C, Testing cable.

MURRAY'S LOOP TEST.

Now, the effect of burning up a fault in order to get a "dead short" between inner and outer for the purpose of the ordinary loop test, is often to obliterate entirely all traces of the cause of the fault, and so to make it impossible to secure sufficient evidence to support a claim for compensation from the presumptive culprit. Further, as is well known, the ordinary loop test gives by no means accurate results in such cases; its application assumes the existence of two generally incompatible conditions, viz., that the resistance of the fault is very small, and that neither the inner nor the outer is much damaged at the fault. By a very slight modification of this test we have obtained very accurate results, without burning up the fault or reducing its resistance to less than about 1,000 ohms. The change we have made consists simply in joining the inner and outer, in the second stage of the test, together at the far end of the cable through a known resistance, variable at will.

If A = resistance of fault plus resistance of inner and outer up to the fault.
B = parallel resistance of fault and circuit formed by inner and outer beyond the fault and the variable resistance, plus the resistance of inner and outer up to the fault.
C = resistance of inner and outer of whole length of cable in series. This is assumed known in advance.
r = value of the variable resistance.
x = distance in yards to the fault.
L = length of cable in yards,

then
$$x = \frac{B - \sqrt{[(A - B)\{(C + r) - B\}]}}{C} . L$$

and, after a preliminary trial, it is not difficult to assign a value to r, which will give accurate results if care has been taken in making connections, allowing for the testing leads, &c.

I much prefer, however, the Murray's loop test, which we have almost invariably used, and by which we have found it possible to localise faults with great accuracy. This method of testing has the great advantage that a resistance of a few thousand ohms at the fault does not matter, so that no attempt at reducing the resistance of the fault is necessary, and the cause of the fault can usually be found with a fair degree of certainty. By this test we have more than once localised a fault, which, on being dissected, has shown merely a single parted wire in the outer, the solder being still visible, and a tiny pinhole through the inner insulation immediately below one of the free ends of the broken wire; the cable was otherwise quite uninjured, and showed scarcely any sign of a current from inner to outer.

In Murray's test either the inner or the outer, preferably the inner as it is more likely to be intact, of the cable up to the fault forms one arm of the bridge; the remaining part of the same conductor and the return lead, which may be the inner or outer of another cable, or a special cable laid along the road surface for the purpose of the test, from the far end of the faulty cable forms the second arm; one set of the proportional coils and the variable bridge resistance form the other two arms of the bridge; whichever of the two conductors of the faulty cable, which is not used as above described, is employed as the galvanometer lead to the junction of the two arms of the bridge at the fault. If,

A = ratio of the resistance of the faulty cable conductor (used as one bridge arm) up to the fault to the resistance of the remainder of this conductor and of the return lead in series.
B = ratio of the resistance of the return lead to the resistance of the whole length of the conductor used as part of the bridge.
L = length of cable in yards.
x = distance in yards to the fault.

then
$$x = \frac{A(1 + B)}{1 + A} . L$$

or, if
$$A' = A$$
$$B' = 1/B$$
$$x = \frac{A'(1 + B')}{B'(1 + A')} L$$

With our arc lighting circuits, where we have the all-night and the half-night cables laid side by side, we have usually used one of these as the return lead for the other; in other cases we have used a 37/20 rubber insulated, wire armoured, single cable, of which we keep a 350 yards length specially for testing purposes. In addition to the two before-mentioned loop tests we have used Heaviside's telephone method, sometimes with and sometimes without success. One drawback to the general use of this method is that the noise of the traffic in the daytime makes it almost necessary to work at night; another is that unless the fault is not merely from inner to outer, but also to earth, which generally means a badly burnt up fault, the method is useless with concentric cables. With heavily taped armoured concentric cables, laid either in dry soil of a sandy character, or in wooden troughs and bitumen, a fault to the lead sheath or armour means that most of the leakage current traverses the armour in both directions along the cable until it gets to earth at the earthed joint boxes; this makes it very difficult to accurately localise a fault in many cases, and sometimes even to form a rough idea where the fault is.

In conclusion of these miscellaneous notes one point (of minor importance) is the designing of mains, upon which further information is, I think, desirable, may be mentioned; I allude to the temperature rise in a cable carrying current. Few experiments, so far as I am aware, have been made to determine—even to but a rough degree of approximation—the rise of temperature in an underground cable, and certainly there are no data generally available upon which a judgment can be formed with respect to different cables laid under different conditions and carrying currents varying according to different load diagrams. The Board of Trade has enacted by No. 4 of their Regulations that "the maximum working current shall not be sufficient to raise the temperature of any conductor . . . . . to a greater extent than 30° of Fahrenheit's theromometer," but it is very doubtful whether any station engineer can say whether his mains comply with this Regulation, and if so, with what margin of safety. A few general conclusions can, of course, be readily arrived at *a priori*; *e.g.*, under similar conditions the current densities in concentric cables should be less than in pairs of single cables; the current densities in similar cables, laid under similar conditions, should be less when the current is for street lighting than when for private supply; the current density should be less the larger the cable—and so forth. Precise information with respect to a few well defined and characteristic cases is wanted—may it soon be rendered available.

DISCUSSION.

Mr. E. W. COWAN opened the discussion by stating that in many central stations the speed of the engines varied, and consequently the periodicity also varied, and he desired to know whether Mr. Kilgour had tried the effect of the varying frequency upon the Westinghouse wattmeter. From hurried tests which he had made he found the meters inaccurate, with a very slight variation of frequency. He was not quite clear on the matter, but he

assumed that the switchbox was filled with oil, and he would like to know of what the insulation of the switch was composed. He thought rubbing contacts under oil were very interesting, but entirely satisfactory. He could not understand, if a fault occurred on a certain section, and the fuses went on that section, why the fuses did not also blow on other sections, and he pointed out the advantages of the Andrews method of distribution. He thanked Mr. Kilgour for his kindly treatment of transformers, and wished that every user would take the same care; he thought manufacturers would have a far better time of it if they did. With regard to the trouble experienced on the arc lighting transformers, he thought this might be due to damp owing to the machines being used intermittently.

Mr. W. H. H. Gee was anxious to have information with regard to the 200-volt change over at Cheltenham, and also any experience the author had had with 200-volt arc and incandescent lamps.

Mr. Shoults could not understand why the current for customers supplied at 200 volts pressure should cost 10 per cent. more than if supplied at a pressure of 100 volts.

Mr. S. Z de Ferranti thought that, although it was certainly the right thing from the point of view of electrical engineering and distribution to supply at the higher pressure of 200 volts, it was startling that customers should be penalised to the extent of a 10 per cent. increase. The Metropolitan Company originally stated that they could supply at almost any voltage, giving some customers 100 volts pressure, but the majority desired to be supplied at 50 volts pressure, as there was found to be a distinct advantage in the use of 50-volt lamps. They were far more efficient, and the cost was not so great. This bore out the present experience. He quite agreed with the author as to the advisability of making all danger as apparent as possible, but at the same time it was essential that death traps should not be left, and that everything should be as safe as possible. He did not think that the members need trouble themselves with regard to the heating of the mains in the street so long as the cable stood. Some tests which were made by the Liverpool inspector on Callender's mains which were originally laid down in Liverpool proved that they were within the bounds of safety.

Mr. Kilgour, in reply to Mr. Cowan, stated that with regard to the Westinghouse wattmeter, he found that a 1 per cent. change of frequency caused about ½ per cent. error. The switchboard boxes were filled with oil, and the rubbing contacts had proved to be exceedingly satisfactory. With regard to the Andrews return current cut-out, he did not like multiplying the mechanical contrivances at the sub-stations, and the use of that method for their extensions would depend largely upon the experience of others. He had not had much experience with 200-volt arc lamps, but there was no doubt that 200-volt incandescent lamps had a considerable lower efficiency than had 100-volt lamps. It meant great effort to get a 16-C.P. 200-volt lamp with a 3½ watts per candle efficiency. With regard to the change over to 200 volts at Cheltenham, they offered their customers 8½ per cent. rebate if current were taken at a pressure of 200 volts, consequently the 10 per cent. increase did not affect them. He promised to make some tests of feeder mains shortly, and he would be glad to communicate to any member regarding the results if desired.

ELECTRIC LIGHTING PROGRESS IN ST. PANCRAS.

The chairman of the Electricity and Lighting Committee (Dr. Walter Smith) has presented to the Vestry a report recording the chief matters which engaged the attention of the committee during 1898. The report shows that in the 12 months 176 additional consumers were connected to the mains, these representing a demand for supply to 5,974 16-C.P. lamps, 36 arc lamps, and 13 motors of a total of 124 horse-power. The net result of the year's trading, after payment of interest and instalments on loans, has been a profit of £4,175. In view of the utility of the tables compiled by Mr. H. J. Menzies (the former chairman of the committee), Dr. Smith has thought it desirable to continue them in the present report.

The first table, which relates to the revenue and expenditure of the electricity undertaking since the inauguration of the first station in 1892, shows that the aggregate profit made down to the end of 1898 amounts to £14,939. In two years, 1892 and 1896, a deficit totalling £3,493 was made, thus reducing the profit to £11,446. The second table gives the number of units sold and the cost and price realised per unit. It is as follows:—

Units Sold, Price Realised and Cost.

Year.	Number of units sold.	Average price realised.	Average cost of production.	Average cost for interest and capital.	Total cost. per unit.
		d.	d.	d.	d.
1892	435,519	6	4·6	2 28	6 88
1893	594,893	6	3 5	1·8	5 3
1894	719,484	5·6	3·2	1 8	5 0
1895	849,987	5 3	3 5	1 6	5 1
1896	1,201,229	5 4	3·8	2 0	5 8
1897	1,520,354	5 2	2·9	1 3	4·2
1898	1,996,877	4·59	2 94	1·15	4·09

In the third table, details are submitted analysing the cost in pence per unit.

Analysis of Costs in Pence per Unit.

Year.	Coal.	Oil, waste, &c.	Wages.	Maintenance and repairs, including carbon.	Rents, rates, and taxes.	Management.	Other expenses.	Total.
	d.	d.	d.	d.	d.	d.	d.	d.
1892	1 63	·24	1·30	·34	—	·72	36	4 60
1893	1 26	17	·72	92	—	34	09	3 50
1894	·99	·15	·71	80	·10	35	·11	3 21
1895	95	·10	·67	1·18	·10	·36	·13	3 49
1896	·99	·17	72	1 07	·12	·53	20	3 80
1897	·84	·09	·61	·92	09	24	·09	2 89
1898	·84	07	·60	1 04	07	·19	·12	2 93

A comparison of the costs in St. Pancras with those obtaining in the case of some of the London companies is given in the fourth table. This indicates that the corresponding total cost with the Charing Cross Company is 2·32d. per unit; the Chelsea Company 2 95d.; the Kensington Company 3 04d.; the St. James's Company 1·94d; the Westminster Company 2 28d.; and St. Pancras 2 93d. In the fifth table it is shown that the capital expenditure in St. Pancras at the end of 1898 had reached £241,993, or at the rate of 2s. 5d. per unit, sold in that year; 2s. 9d. in 1897; 3s. 1d. in 1896; 2s. 8½d. in 1895; 3s. 0½d. in 1894; 3s. 2½d. in 1893; and 4s. 1d. per unit sold in 1892.

With regard to the Regent's Park station the report points out that the extensions are progressing, and that it is hoped they will be completed in order to meet the coming winter's demand. The plant to be installed under existing contracts comprises two 750-H.P. engines and dynamos and four dry back marine boilers together with condensing plant and feed water heaters. In addition to these the Vestry recently sanctioned a further expenditure of £19,000 for two other engines of similar powers and two additional boilers. The plant at the King's Road station is now fully employed, and the question of extending the station is receiving the attention of the Electricity Committee. In the meantime the water in the North Metropolitan Canal is being utilised for condensing purposes.

The report then deals with the extensions in the public arc lighting and gives a complete and comprehensive list of the streets in which mains are laid throughout the parish. It mentions that during the year one claim was made under the Workmen's Compensation Act, and that this was satisfied by the payment of £90 under the policy taken out with the Scottish Employers Liability Insurance Company. The present capacity of the Regent's Park station is 1,060 kilowatts, and that of the King's Road station, 700 kilowatts. In conclusion, the report gives the following table, showing the largest demand upon the two stations during the year ending in April last:—

Month.	Amperes.		Total amperes.
	Regent's Park.	King's Road.	
1898.			
May	5,240	2 980	8 220
June	4,070	2 870	6,940
July	4 820	2 780	7,600
August	4,250	2,993	7,243
September ...	5,100	3,680	8 780
October... ...	5 800	4,540	10,340
November ...	6 340	4,870	11,210
December ...	6,500	5,030	11,530
1899.			
January ...	7,180	4,830	12,010
February ...	6,660	4 860	11,520
March	6,140	4,805	10,945
April	6,500	4,650	11,150

ALUMINIUM FOR SWITCH WORK, BUS BARS, &c.

By ERNEST KILBURN SCOTT.

The rise in copper is becoming a serious matter for electrical firms, and although there seems little doubt that it will eventually collapse, this desirable event may not happen for many months. One result of the rise productive of much good is the increased attention which is being given to aluminium as an electrical conductor. Owing to increased production,* the price of aluminium has been gradually

* In the United States of America the total output of aluminium during 1897 was over three times the output of the year 1896.

creeping down until, taking into account their relative conductivities and weights, the two metals, aluminium and copper, almost overlap at present prices.

The advantage of using aluminium on a large scale as an electric conductor was first recognised by the Aluminium Reduction Company at Niagara. About 3,000 H.P. had to be transmitted at 300 volts, continuous current, from the turbine house on the river bank to the reduction building at the top of the cliff, a distance of about 280 feet, and for this purpose a number of bare aluminium rods, about $\frac{3}{4}$-inch diameter were employed. Current was also distributed to the various aluminium pots by means of rectangular section bus bars of aluminium of about 7 square inches cross-section. The plant was put down about three years ago, but even at that time the total cost of the installation is said to have shown a saving over copper, and the company's engineers were convinced that aluminium had a future as an electric conductor.

Of course, owing to its greater sectional area for a given current, it is as a bare conductor that it shows to best advantage. There are many cases where it could be used as, for example, the bus bars of large switchboards either to fasten directly on the slate or be supported behind the board by projections from the cast-iron standards. The increased sectional area gives larger contact surface for connection bolts, cable eyes, &c.

As Connections between Accumulator Switches and the Regulating Cells.—This is always a very heavy item, but especially so where the generating station is badly planned and the switchboard a long way from the regulating cells.

As Switch Arms.—Heavy currents and long breaks necessitate switch levers of 18 inches, or even more, in length, and these if made of a copper alloy or gun-metal bring considerable stress to bear on the slate or marble on which they may be mounted. Obviously, with a light weight switch arm a more sudden break can be allowed.

For Transmission of Power Lines.—Many of the long distance transmission schemes abroad are for mines, &c., situated in most inaccessible places, and therefore on account of the considerable saving in the weight there seems to be an opening for the use of bare aluminium wire, and incidentally also there would be a slight saving in insulators.

For Removable Telephone and Telegraphic Lines.—The reduction in weight is a specially valuable feature for field military purposes, as the size of the conductor for such work is fixed at a certain minimum size for mechanical reasons. The saving in weight over copper is therefore practically as 3·3 is to 1.

Portable Testing Instruments.—Some of the portable testing sets, ammeters, ohmmeters, &c., at present on the market are exceedingly heavy, and although there are comparatively few users of such apparatus, makers would undoubtedly find it pay to use the lighter metal more freely.

Brush-holders.—Aluminium alloy castings have been used for brush-holders because of the variation of pressure (due to gravity) between the brushes on the top side and those on the under side of a commutator. The lighter castings reduce this variation, whilst at the same time the total weight on the brush rocker is considerably reduced in large machines.

Pure aluminium has a specific conductivity 67 per cent. that of pure copper. With $\frac{1}{2}$ per cent. of impurity the conductivity is reduced to 61 per cent., whilst with 1 per cent. impurity the conductivity is 59 per cent. It is when we compare the castings made in the two metals that aluminium shows to best advantage, for although both must be alloyed with other metals to give sound castings, the reduction in conductivity on this account is relatively greater with copper than with aluminium. Good nickel aluminium castings can be made having a conductivity of 45 to 50 per cent. that of rolled copper, but it is very seldom that ordinary copper alloy castings such as are used every day for switch work and similar purposes exceed this figure. There is little difference in the tensile strengths.

For some time there was a difficulty in getting good aluminium alloy castings, but this has now practically disappeared owing to brass founders and others having learnt by experience the peculiarities of the metal. Soldering and brazing, although they can be performed, are still drawbacks when compared with copper, but there is this to be considered, that for most of the purposes enumerated above mechanical joints may be used; in fact, for some purposes they are preferred.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by **W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham,** *to whom all inquiries should be addressed.*

9,606. "Improvements in electric telephony." C. Adams-Randall. Dated May 8th.

9,607. "Improvements in phase transformers and the application of the same to starting monophase electric motors." E. B. Wedmore. Dated May 8th.

9,616. "An improved method of displaying advertisements, pictorial or otherwise, by projection with lenses and clockwork movement or electric motor." W. Thomson and the "Jactho" Patent Automatic Advertising Lamp Company, Limited. Dated May 8th.

9,622. "Improvements in electrically heated smoothing irons or the like." W. D. Ferguson and T. H. McMurray. Dated May 8th.

9,631. "Improvements in or connected with electrical conductors and anodes for electrolytic and similar purposes." The General Electrolytic Parent Company, Limited, L. Hargreaves and W. Stubbs. Dated May 8th. (*Complete.*)

9,632. "An improved high insulation lampholder." F. W. Heaton and H. Smith. Dated May 8th. (*Complete.*)

9,659. "Improvements in electric signalling instruments." H. W. Sullivan. Dated May 8th.

9,672. "Improvements in electric switches." J. E. Spagnoletti and J. Crookes. Dated May 8th. (*Complete.*)

9,674. "Improvements in telephones." E. Wilson, C. J. Evans and H. Godsal. Dated May 8th.

9,681. "Improvements in circuit breakers." R. Belfield. (L. B. Stillwell, United States.) Dated May 8th.

9,707. "A new or improved magneto-electric machine." H. A. Dawson. Dated May 9th.

9,721. "Improvements in electrical distribution boards." J. R. Craig, jun. Dated May 9th.

9,723. "Improvements in thermopiles." E. D. Young. Dated May 9th.

9,729. "Improvements in or relating to the Marconi system of wireless telegraphy." G. H. Smith. Dated May 9th.

9,750. "Improvements in printing telegraphs." B. J. B. Mills (J. R. Tucker, C. C. Hinckley, and K. Himrod, United States.) Dated May 9th. (*Complete.*)

9,791. "Improvements in apparatus for receiving Hertz electric undulations or waves." E. Ducretet. Dated May 9th. (*Complete.*)

9,811. "Improvements in or relating to the manufacture of insulating material for electric cables and the like." G. E. Heyl-Dia. Dated May 9th.

9,813. "Improvements in telephones, microphones, and the like, and in switch mechanism for same, automatically operated by the introduction of a coin." Dated May 9th.

9,822. "A new or improved switchboard or block for electrical purposes." A. L. W. Ward and K. Wilson. Dated May 10th.

9,848. "Improvements in electric letter boxes and call boards." J. P. Moore. Dated May 10th.

9,882. "Improvements in electric lighting apparatus, especially applicable for railway and other vehicles." E. J. Preston (of the firm of J. Stone & Co.), and A. B. Gill. Dated May 10th.

9,894. "Improvements in, or connected with, lamps or lanterns." S. Willoughby and E. J. Wickenden. Dated May 10th.

9,938. "A new or improved protective conduit for the current conveyers of electric railways." A. Petzenburger and A. Haisl. Dated May 11th. (*Complete.*)

9,966. "Improvements in the manufacture of protecting casings or tubular structures for electric cables." A. J. Boult. (J. Jungbluth, Germany.) Dated May 11th. (*Complete.*)

9,972. "Inverted third rail electric railway system." L. E. Walkins. Dated May 11th.

9,981. "Electrically-driven machines." T. H. Joseph and J. J. Ehrenreich. Dated May 11th.

9,987. "An improved binding post or device for connecting electrical apparatus." H. H. Lake. (A. R. Shuttuck, United States.) Dated May 11th. (*Complete.*)

9,989. "Improvements in, and relating to, the governing of engines used for driving electric generators in electric distributing systems." H. A. Mavor. Dated May 11th.

9,999. "Automatic electrical ring-off appliance for telephone stations." Siemens Bros & Co., Ltd. (Siemens & Halske Actiengesellschaft, Germany.) Dated May 11th. (*Complete.*)

10,016. "Automatic electro-magnetic switch applied to incandescent lamps for lighting the same in series to prevent the possibility of a pillar being in darkness." F. Carter. Dated May 12th.

10,029. "Improvements connected with the controlling of shop window illuminating electric lamps and the like." W. Douglas. Dated May 12th. (*Complete.*)

10,035. "Improvements in apparatus for the production of ozone by electricity." J. H. Lamprey. Dated May 12th.

10,040. "Improvements in printing telegraphs." L. Cerebotani and A. Silbermann. Dated May 12th. (*Complete.*)

10,065. "An improved antiseptic mouthpiece for use in connection with telephones and the like." H. H. Lake. (C. W. Hutchings, United States.) Dated May 12th.

10,081. "Improvements in electrical resistances and similar apparatus." M. Levy. Dated May 12th.

10,094. "A device for shielding fallen wires from overhead electrical conductors, and for supporting the latter." G. S. Holmes. Dated May 13th.

10,095. "A device for shielding fallen wires from overhead electrical conductors." T. Holmes and A. Smith. Dated May 13th.

10,105. "Improvements in and relating to incandescent electric lamps." F. Sadler. Dated May 13th.

10,109. "Improvements in joint boxes for electrical installations and connections therefor." G. Wilkinson. Dated May 13th.

10,119. "Improvements in electrodes for batteries." G. Heidel. Dated May 13th. (*Complete.*)

10,124. "Improvements in telegraphic instruments." P. B. W. Kershaw and H. H. Shanks. Dated May 13th.

10,130. "Improvements in and relating to electric arc lamps." J. W. Ewart. Dated May 13th.

10,133. "Improvements in systems of control for electrically-propelled vehicles." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated May 13th. (*Complete.*)

10,134. "Improvements in controlling devices for electric motors." The British Thomson-Houston Company, Limited. (F. E. Case, United States.) Dated May 13th. (*Complete.*)

10,135. "Improvements in controlling devices for electric motors." The British Thomson-Houston Company, Limited. (W. B. Potter, United States.) Dated May 13th. (*Complete.*)

10,136. "Improvements in systems of controlling electrically propelled railway trains." The British Thomson-Houston Company. (H. W. Beck, United States.) Dated May 13th.

10,150. "Improvements in thermostatics." F. W. Goldby. (L. Morgenstern, Germany.) Dated May 13th.

10,153. "An improved method of controlling mechanisms by means of Hertzian waves." E. Wilson, C. J. Evans, and H. Godsal. Dated May 13th.

10,163. "Improvements in magnetic circuit breakers." H. H. Lake. (W. M. Scott, United States.) Dated May 13th.

10,164. "Improvements in interrupters for electric currents." H. T. Simon. Dated May 13th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, *price, post free,* 9d. *(in stamps).*

1897.

12,455. "Improvements in and relating to prepayment devices for use with telephones." S. Silberberg. Dated May 20th, 1897. Telephones:—Relates to telephonic apparatus operated by a special key, purchasable previously instead of by a coin. The key thrust into a rotary holder disengages a bolt by its cam-groove, and is then turned through a quarter of a revolution into the position shown, so that it engages a pair of jaws which extend from a sliding rack in engagement with a pinion loose on a handle shaft. The shaft which have to be turned to ring up the connecting clerk is coaxial with the handle shaft and has a ratchet clutch engagement with it. Normally it is locked by a bolt engaging a fast notched wheel, but an arm projecting from the key-holder draws the bolt. After ringing up the clerk and getting connected, the user turns the handle in the reverse direction, whereby through the intervention of another ratchet clutch the low pinion is turned, and the rack draws the key into the apparatus. The key thrusts before it the vertical arm of a bell crank having a horizontal arm, which lifts a rack bar, the subsequent descent of which is timed by clockwork. Both in rising and descending the bar makes two signals which tell the controlling clerk when to let the conversation begin and end. 10 claims.

12,469. "An improved method of arranging the coils of a set of electrical resistances, and means for manipulating the same." J. H. Reeves. Dated May 20th, 1897. Resistances arranged in parallel sets connected in two circuits are provided with blocks and plugs, such that insertion of one plug cuts out corresponding resistance in both circuits. Two series of blocks are separated by insulation and connected to the resistances. Each plug is made with two conducting rings separated by insulation. 1 claim.

12,549. "Improvements in plates for accumulators." W. Majert. Dated May 20th, 1897. Plates or electrodes are built up of bars or ribbons which are corrugated, as shown, for the purpose of more securely holding the paste. The projecting portions of ribbed plates may be treated in the same way, and polygonal or other gratings may be corrugated at the edges. 2 claims.

12,957. "Improvements in transforming alternating into continuous electric currents or *vice versâ*." A. Muller and H. Tudor. Dated May 26th, 1897. Relates to means for converting alternating into direct currents, and *vice versâ*, for charging secondary batteries, &c. In converting an alternating current from a generator, a commutator is driven synchronously by a motor, and to prevent sparking at the contacts a polarisation battery is switched in for the period when the tension of the current is below that of the secondary battery. The commutator carries a number of contacts, connected with rings on which the brushes rub, connected with the battery. Between these contacts are contacts connected to the rings on which the brushes rub, connected with the polarisation battery. The brushes are connected to the generator. The apparatus may be used for converting continuous into alternating currents by supplying a continuous current from a battery or other source, and rotating the commutator by a suitable motor. Similarly, it is stated, polyphase currents may be converted, and *vice versâ*. 1 claim.

13,970. "Improvements in and relating to dynamo-electric machines and rotary converters." The British Thomson-Houston Company, Limited. (E. W. Rice, jun.) Dated June 8th, 1897. Alternating current machines, single-phase or otherwise, and especially rotary converters for direct and alternating-currents, are made with any number of pairs of field poles, and with ring or drum armatures in which equipotential points around the armature are connected together and to connecting rings. The alternating current connections of a ring armature in an 8-pole machine are shown with points arranged similarly with regard to like poles, N.S., being connected together and to one of the collecting rings, to give three-phase currents; the armature is also connected for converting to an ordinary continuous current commutator, not shown. The object is to electrically balance the armatures. 2 claims.

13,974. "Improvements in lightning arresters." The British Thomson-Houston Company, Limited. (Axel Ekstrom.) Dated June 8th, 1897. A series of conducting balls are mounted on an insulating base. The ball at one end is connected to lines, while a number of balls at the other end of the series are connected by wires to fuses leading to earth. As each fuse breaks an extra spark gap is formed. A non-inductive resistance may be connected to the earth. 4 claims.

20,913. "Machine for painting electric casing and the like." G. H. Cutting and G. Cutting. Dated September 11th, 1897. Relates to apparatus for painting electric casings and similar strips. The casing is passed by rollers through a receptacle in which brushes are rotated to paint the sides of the casing. The shafts of the rollers and of the brushes are all geared together by wheels. The paint is fed by a pipe from a receptacle. The surplus paint drops into a well and serves to feed the lower brushes. The receptacle is fitted with a tap to draw off the paint from the well when required. 3 claims.

20,996. "Improvements in electrical cut-outs." C. M. Dorman and R. A. Smith. Dated September 13th, 1897. The vents in fuse cases are covered by a layer of wire gauze or other permeable incombustible material. The vent is closed by a layer of wire gauze or other porous fabric. In a modified device in which a channel or chamber in the base is filled with incombustible material such as asbestos, or a bundle of wires or the like. A porous fabric may also be arranged. The fuse case may be partially constructed of gauze after the manner of a Davy lamp. 3 claims.

21,110. "Improvements in arc lamps with double globes." W. H. Wheatley. (Allgemeine Elektricitäts Gesellschaft, Germany.) Dated September 14th, 1897. Relates to a clutch lamp with an enclosed arc. The lower carbon and inner globe are carried by rods on a plate. The upper carbon passes through a circular clutch which is connected by links and levers with the armature of an electromagnet carried on the plate. The clutch consists of a block having radial slots to receive rollers, and an annular slot to receive short axles on these when the clutch is lowered, the rollers are moved upwards and outwards by contact with an annular stop disengaging the carbon. The inner globe is closed by a cover which rests on it and is held in place by the guide rods. The outer globe is cemented into the bottom of a cylindrical casing which is hung by links from hooks on a sling. The plate of the lamp rests on the casing and is held in place by pins engaging vertical slots in the sling, thus closing the casing and outer globe. 5 claims.

22,206. "Machine for making storage battery plugs." C. Potter. Dated September 28th, 1897. Consists of a machine for coiling up lead ribbon into spiral plugs for use in secondary batteries. The ribbon may first be fed between two adjustable rolls, one of which has a grooved surface so as to form a ribbed or roughened face on one side of the ribbon, but this operation may be dispensed with, or be otherwise performed. The ribbon then passes between two adjustable feed rolls, and is cut into pieces of the length required by a revolving cutter. The length required may be varied by altering the speed of the cutter. The ribbon is then fed along by a reciprocating pawl and passes under a wheel and over a spring roller between two grooved or roughened surfaces, the former of which rotates while the latter is pressed upward by springs, so that a coil is formed. In a modification the surfaces are rectangular instead of cylindrical. 9 claims.

27,508. "Improvements in and connected with the extraction of gold by electrolysis." O. March. Dated November 23rd, 1897. The object of the invention is to provide a suitable apparatus for the extraction of gold from ores by electrolysis. A vessel of any convenient shape has the bottom floored or tiled with carbon plates, and having attachments for electrical connection. This floor forms the anode. The vessel is then partly filled with crushed ore and a solution of any suitable chloride. At the upper part of the vessel a tray is placed with a perforated bottom. In this tray a plate of metal is placed to form a cathode. 4 claims.